MONTANA HIGHWAY

FUNCTIONAL CLASSIFICATION AND NEEDS STUDY

1974 UPDATE

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June 19, 1974

Mr. Paul R. DeVine, Chief
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Hustad Center
Helena, Montana 59601

Subject: Montana Highway Functional Classification and Needs Study - 1974 Update
Final Report

Dear Sir:

It is our pleasure to submit this report on the Montana Highway Functional Classification and Needs Study - 1974 Update to the Planning and Research Bureau of the Montana Department of Highways in fulfillment of our contract agreement.

This report contains the results of the highway needs study that was conducted for a functionally classified system of highways in Montana. It is intended that the data be used for the transition to a Federal-aid system of highways composed of functionally classified routes after June 30, 1976 as required by the 1973 Federal-Aid Highway Act.

The needs reported in this study include total needs for the 1974 to 1994 (twenty-year) period. The highway needs estimated are $8,334,409,000, about 2½ times the estimated available funding of $3,268,000,000.

We would like to thank the Planning and Research Bureau and the Federal Highway Administration for their assistance and review, and extend our appreciation for the opportunity to conduct this study. Comments from those local agencies that put substantial effort into reviewing the functional classification in their jurisdictions is also gratefully acknowledged.

Sincerely,

Robert J. Peccia

Robert J. Peccia, P.E.

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ABSTRACT

In 1971 the Montana Department of Highways conducted the Montana Highway Functional Classification and Needs Study (1970-1990). That study was part of a national highway study mandated by Congress, administered by the Federal Highway Administration, and conducted by all of the states. That study was the first time that a total highway needs study conducted in all states and using uniform criteria had been completed. At that time it was conjectured (but not known) that the highway functional classification study would be used to realign the Federal-aid highway system.

The results of that study are contained in a report to Congress entitled the *1972 National Highway Needs Report.* This report was prepared and submitted to Congress in March of 1972. Data contained in that report significantly affected legislation for highways. The 1973 Federal-Aid Highway Act in particular reflects some of the recommendations of that report.

In any national study, however, there are states that do not fit standards established for the average state. Montana is one of these. The rural nature and low population density of Montana require design standards that are in conflict with the design standards established by the Federal Highway Administration for the 1970-1990 Study.

The Montana Department of Highways recognized this problem, as well as the significance of realigning the Federal-aid system on a functional basis. Limitations of such a study conducted for the first time and without a well defined purpose were also noted. Limited interest and input at the local level provided additional justification for the decision to reconduct the study based upon state design standards and using state criteria. This report contains the results of an update of the 1970-1990 Study, and is entitled the *Montana Highway Functional Classification and Needs Study - 1974 Update.*

During this study, we have been very conscious of placing emphasis on local priorities and preferences. All officials of urban areas over 5,000 and all county commissioners were invited to participate and comment on the highway functional classification. Reviews and comments from a majority of these cities and counties were received and an attempt was made to incorporate local preferences whenever consistent with the criteria.

The 1974 Update is a substantial refinement on both the highway functional classification and the needs analysis from the 1970-1990 Study. However, planning of highways is a dynamic process, and as conditions change so will this study. It is our belief that we have provided the most complete picture of highway needs in Montana based upon current information, and hope that this study will prove beneficial in the continuing highway planning process.

PART I

INTRODUCTION

PART I – INTRODUCTION

A. INTENT OF STUDY

When the Montana Highway Functional Classification and Needs Study (1970-1990) was conducted by the Department of Highways in 1971, there were several weaknesses in the study which the Department of Highways felt should be rectified. These weaknesses were as follows:

(1) As the Department of Highways solicited comments and reviews on functional classification from local agencies, it was difficult to convince the local agencies of the importance of the study. This was because no commitment to realign the federal-aid system had been made by the Department of Transportation, and the Department of Highways could only conjecture on the future use of the study. Consequently, the input from local agencies was not as thorough as it should have been.

(2) To allow for needs comparisons between states across the nation, the 1970-1990 Study used the same minimum tolerable conditions and design standards across the nation. In Montana, many of these standards were not consistent with design and construction standards currently being used in the state. It was therefore felt that a modification of the 1970-1990 Study should utilize current Montana construction criteria to give a realistic estimate of the total highway needs in the state.

(3) The sampling procedure used in the 1970-1990 Study was considered inadequate for the state's use in particular project needs. The 1974 Update therefore provided for a 100% inventory of projects that were potentially on the state system.

(4) New data coming to light since the 1970-1990 Study included the construction of Big Sky Recreation Area, new population information, several new transportation and comprehensive development plans, a secondary roads study, and an increased interest in realignment of the federal-aid highway system on a functional basis. This new information affected the functional classification and needs study, and required that adjustments be made.

The study described in this report, the Montana Highway Functional Classification and Needs Study - 1974 Update, has taken these considerations into account and has incorporated the following:

(1) Increased participation from local agencies.

(2) Adjustments to agree with new transportation studies.

(3) Revised minimum tolerable conditions and design standards to agree with current Montana standards.

(4) Costing figures updated to 1971 and 1972 prices.

(5) Increased sampling to 100% on roads which may become part of the federal-aid system.

B. STUDY ORGANIZATION

This study was conducted with highway planning and research funds. The Planning and Research Bureau of the Department of Highways conducted the study in cooperation with the Federal Highway Administration. The Department of Highways retained the consulting firm of Menasco-McGuinn Associates to provide the staffing effort required to complete the study.

Concurrently with the Montana Highway Functional Classification and Needs Study - 1974 Update, two other studies were also conducted: (1) The 1974 National Highway Needs Study requested by the Federal Highway Administration, and (2) Montana's portion of the 1974 National Transportation Study requested by the United States Department of Transportation. The results of these two reports are contained in separate publications.

C. HISTORY OF HIGHWAY FUNCTIONAL CLASSIFICATION

A highway functional classification and needs study is composed of two relatively independent studies: a highway functional classification study and a needs analysis study. Highway functional classification is the process of grouping highways into classes according to their use or function. Needs analysis is the process of estimating the cost to upgrade the functionally classified highways to an established standard.

Since the design standards (and hence the costs) are dependent upon the functional classification, the two studies are inter-related. Studies relating to highway functional classification and needs that have been done in Montana or are currently underway are as follows:

(1) 1968 National Highway Functional Classification Study - State of Montana

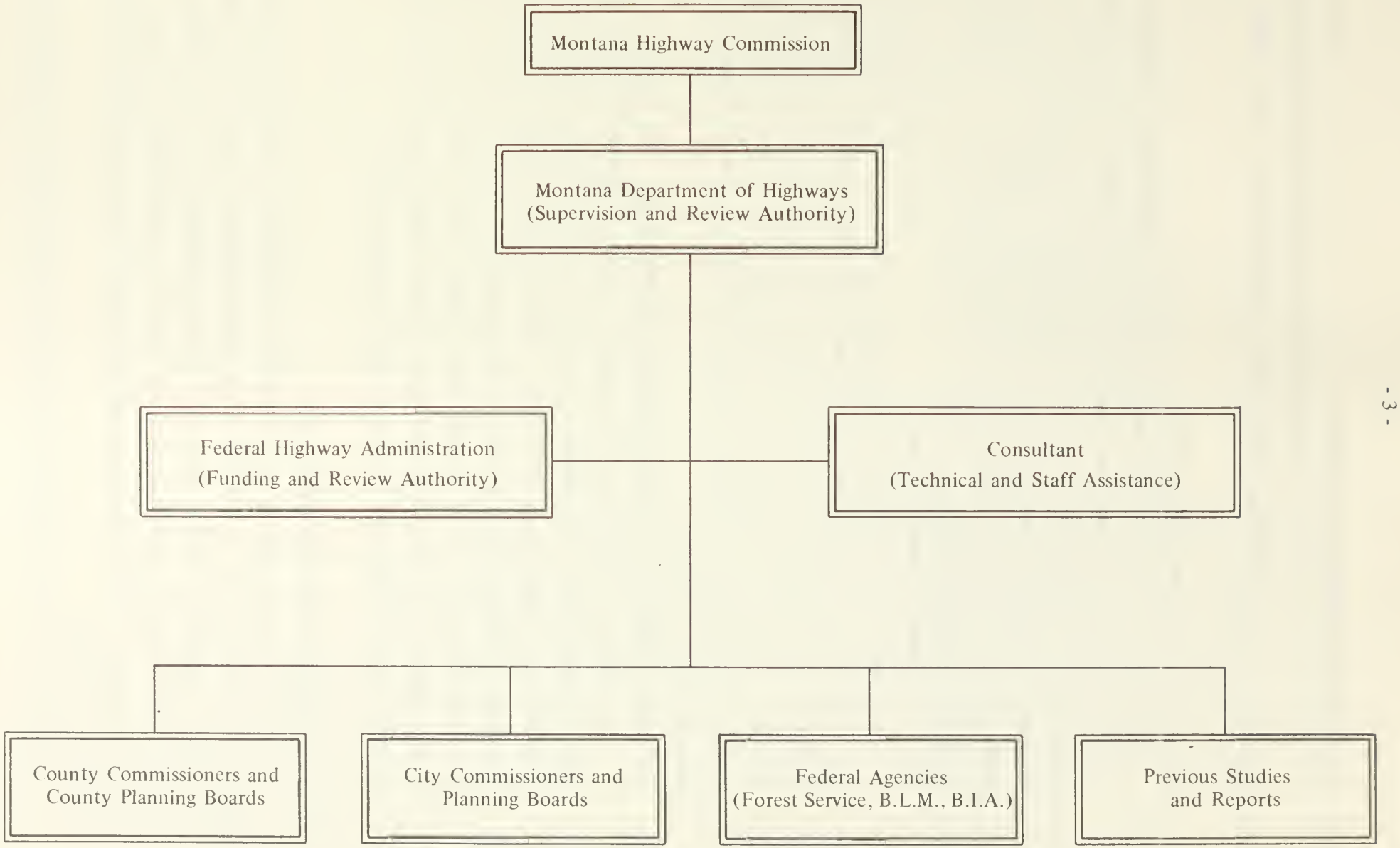
The first national study on highway functional classification was the *1968 National Highway Functional Classification Study*. This study functionally classified all highways in the United States based upon how they functioned in 1968. No projections were done and no needs were estimated. This study looked at highways as they existed in 1968, and established their functional classification. This study provided the basic highway functional classification from which other studies projected.

(2) National Highway Functional Classification and Needs Study (1970-1990)

The sequel to the 1968 National Highway Functional Classification Study was the National Highway Functional Classification and Needs Study (1970-1990). This study, using the 1968 Study as a base, projected a highway functional classification for conditions as they would exist in the year 1990. In addition, the needs to construct, maintain, and administer the 1990 system to an adequate level based upon national standards were estimated. Because of the scope of the study and the limited time available, needs were estimated on a sampling of each functional system.

FIGURE NO. 1

ORGANIZATION FLOW CHART



(3) 1974 National Highway Needs Study

To aid the Federal Highway Administration in evaluating the needs as reported in the 1970-1990 Study, the Federal Highway Administration requested additional data on highway needs. This study provided that data.

(4) 1972 National Transportation Study

This study was a multi-modal transportation study encompassing the intentions and results of the National Highway Functional Classification and Needs Study, but expanding the scope to all modes of transportation. This study was administered at the national level by the Department of Transportation and again conducted by the states. The intent of the study was to gather data on all modes of transportation and to assess alternate levels of transportation investment by the federal government.

(5) 1974 National Transportation Study

As a sequel to the 1972 National Transportation Study, this study provides the best picture available on the existing state and proposed state of the transportation systems in the United States. Administered by the Department of Transportation, this study reports data in three parts: (1) the 1972 Inventory; (2) the 1980 Program; and (3) the 1990 Plan. To insure that the data submitted is reasonable, the sources of funds to be used to finance the 1980 Program also had to be reported.

(6) Montana Highway Functional Classification and Needs Study - 1974 Update

The study that is reported in this document, the Montana Highway Functional Classification and Needs Study - 1974 Update, is a refinement of the National Highway Functional Classification and Needs Study (1970-1990). This study approaches highway needs from the standpoint of state rather than national criteria and standards. Also, all roads that may be part of the federal-aid system in the future (principal arterials, minor arterials, and major collectors in rural areas, and principal arterials and minor arterials in urban areas) were inventoried 100% to give a more accurate picture of needs on the state system of roads.

D. 1973 FEDERAL–AID HIGHWAY ACT

The 1973 Federal-Aid Highway Act was passed by Congress just as the Montana Department of Highways was beginning the 1974 Update of the Montana Highway Functional Classification and Needs Study. Statements contained in the 1973 Federal-Aid Highway Act on the realignment of the federal-aid highway system added support to the need for a thorough highway functional classification and needs study. These statements, contained in Section 148 of the *Federal-Aid Highway Act of 1973*, are as follows:

– *After June 30, 1976, the Federal-Aid primary system shall consist of an adequate system of*

connected main roads important to interstate, statewide, and regional travel, consisting of rural arterial routes and their extensions into or through urban areas.

– *After June 30, 1976, the Federal-Aid secondary system shall consist of rural major collector routes.*

– *After June 30, 1976, the Federal-Aid urban system shall be located in each urbanized area and such other urban areas as the state highway departments may designate, and shall consist of arterial and collector routes, exclusive of urban extensions of the Federal-Aid primary system.*

As noted by these statements, the highway functional classification and needs studies that have been completed in the past have been used to develop meaningful legislation on highways. The Montana Highway Functional Classification and Needs Study just completed and contained in this report will put Montana in a better position to adjust the state's federal-aid system as required by the Federal-Aid Highway Act of 1973.

PART II

HIGHWAY FUNCTIONAL CLASSIFICATION

PART II – HIGHWAY FUNCTIONAL CLASSIFICATION

A. DESCRIPTIONS OF HIGHWAY FUNCTIONAL CLASSIFICATIONS

Highway functional classification is described as:

> *...the process by which highways are grouped into classes or systems according to the type of service they are intended to provide.*

The highway classifications used in this study and the characteristics of these classifications are as follows:

(1) Rural Systems

The rural highway functional systems are comprised of principal arterials, minor arterials, major and minor collectors, and local roads.

(a) Rural Principal Arterials

Rural principal arterial is the highest level of rural highway functional classification. This system of highways is characterized by the longest trip lengths and heaviest travel densities, and is intended to serve most large urban areas. In addition, this system is an interconnected network of continuous routes without stub connections. The interstate system is an automatic component of this classification of highway. The percentage guidelines on rural principal arterials, specified by the Federal Highway Administration, are 2 to 4 percent of the total rural miles.

The 1990 rural principal arterial system developed for Montana consists of 4.6 percent of the total rural mileage. This is .6 percent above the upper limit of 4 percent specified by the Federal Highway Administration. However, it is felt that the State of Montana consisting of large undeveloped area having little or no road mileage (almost 30 percent of the state is federally owned of which the vast majority is national park, wilderness and national forest area, or Indian reservation) is a valid exception from the percentage limits. These large areas of little or no road mileages decrease the number of total rural miles, which consequently increases the percent of rural principal arterial mileage. The rural principal arterial system that was designated is considered to be the minimum highway network required for travel of the type that is specified for this system.

(b) Rural Minor Arterials

Rural minor arterial is the next level of rural highway functional classification. These highways link cities and larger towns not connected by a rural principal arterial, are spaced so that all developed areas of a state are within a reasonable distance of an arterial highway, and provide service to travel of primarily intrastate importance. This system interconnects with the rural principal arterial system and forms an integrated network of arterial highways.

(c) Rural Major and Minor Collectors

Rural major and minor collectors provide service to travel of primarily intra-county importance, with travel lengths and speeds being less than those on the arterial systems. The rural major collectors serve the more important travel generators in the counties such as county seats, consolidated schools, mining areas, etc., and the more heavily trafficked corridors. The minor collectors are primarily for land use and are spaced at intervals consistent with population density, and provide service to the remaining smaller travel generators.

(d) Rural Local Roads

Rural local roads consist of the roads which were not classified under a higher system. Their purpose is to provide land access and service to travel over short distances.

Percent limitations by system recommended by the Federal Highway Administration and the actual percent of mileage in each system for the rural systems are as follows:

Functional System	1990 Mileage	%	Recommended % Limits
Principal Arterials	3,127.6	4.6	2 - 4
Principal Arterials plus Minor Arterials	6,979.8	10.3	6 - 12
Major and Minor Collectors	16,274.8	23.9	20 - 25
Local Roads	44,676.2	65.8	65 - 75

(2) Urban Systems

The urban highway functional systems are comprised of principal arterials, minor arterials, collectors, and local streets.

(a) Urban Principal Arterials

Urban principal arterial is the highest type of urban highway functional classification in an urban area. These highways serve the major centers of activity, the highest traffic volume corridors, and the longest trip lengths within an urban area, carry a high proportion of the projected travel on a minimum of mileage, and form an integrated network of highways. Connecting links of rural principal and minor arterial highways, (those highways which provide rural-to-rural continuity through an urban area) are automatically classified as urban principal arterials. As with the rural principal arterials, interstate highways are an automatic component of the urban principal arterial system.

(b) Urban Minor Arterials

Urban minor arterial is the second level of highway in the urban functional classification. The urban minor arterials interconnect with and augment the urban principal arterials, provide service to trips of moderate lengths, offer a lower level of travel mobility than

urban principal arterials, and serve urban travel generators of moderate importance. Urban connections to all rural major collectors and most rural minor collectors are classified as urban minor arterials.

(c) Urban Collectors

Urban collectors are intended to provide land access service and to channel traffic from local roads to the arterial systems. Minor traffic movements within residential, commercial, or industrial areas are also a function of the urban collector system.

(d) Urban Local Streets

Urban local streets consist of all the remaining highways not on one of the higher systems. The purpose of this system is to provide land access and access to a higher type of highway.

Percent limitations by system recommended by the Federal Highway Administration and the actual percent of mileage in each system for the urban systems are as follows:

Functional System	1990 Mileage	%	Recommended % Limits
Principal Arterials	253.8	8.4	5 - 10
Principal Arterials plus Minor Arterials	533.3	17.6	15 - 25
Collectors	285.8	9.5	5 - 10
Local Streets	2,207.5	72.9	Remainder

B. REVIEW OF 1970-1990 STUDY

A substantial part of the 1974 Update of the Montana Highway Functional Classification and Needs Study was based on the Montana Highway Functional Classification and Needs Study (1970-1990). The 1970-1990 Study was mandated by Congress, administered by the Federal Highway Administration, and conducted by the states. The criteria for this study was established by the Federal Highway Administration, and closely controlled so that the results could be compared across the nation. The 1974 Update, in contrast, was initiated by the state to prepare for the realignment of the federal-aid system on a functional basis. State standards were used, and an extensive effort was made to obtain local participation.

The approach used to conduct the 1974 Update was to review and use the 1970-1990 Study as a base. Most of the urban areas and counties had responded to the 1970-1990 Study, and commented on the functional classifications in their areas. It was initially felt that the 1970-1990 Study could be used as a base with very few changes. However, as we progressed through the 1974 Update, it became very clear that two factors resulted in a number of changes being made in the classified systems at the local level. These factors were: (1) as officials in local jurisdictions changed, so did

priorities on the importance of roads within these jurisdictions, and (2) since the 1973 Federal-Aid Highway Act clarified and substantiated the realignment of the federal-aid system significantly more interest was generated during the 1974 Update.

By using the 1970-1990 Study as a base, and adjusting to correspond to new priorities as established by comments from local agencies, the functional classification as it evolved during the 1974 Update should be very compatible with the needs of the state. It is cautioned, however, that as local officials and local conditions change, so do local priorities. Provisions should be made for flexibility in the highway functional classification systems to permit modifications which are supported by factual data.

C. LOCAL PARTICIPATION AND COMMENTS

A concerted effort was made during the 1974 Update to involve local agencies to the extent possible. Letters were sent to all county commissioners, mayors of cities over 5,000 population, and to city-county planning directors of cities over 5,000. In addition, a presentation was made at the annual meeting of the League of Cities and Towns, and a notification was placed in the monthly bulletin distributed to all county commissioners by the Association of County Commissioners.

All of these agencies were offered an opportunity to attend a meeting in their area on the highway functional classification and needs study. To present data and answer questions at these meetings were representatives of the Department of Highways, Federal Highway Administration, and the Consultant. The division engineer for the Highway Department for the area also attended the meetings. Discussed during the meetings were the background of highway functional classification, criteria for each classification, limitations of mileages, and the functional classification developed during the 1970-1990 Study. Each local agency was requested to comment on the functional classification in their jurisdiction. Every attempt was made to comply with local requests within the limitations of the criteria established.

In those cases where the local agencies were unable to attend the meetings, it was requested that they send their comments by letter to the Planning and Research Bureau, Department of Highways for consideration.

The offer was also made to the local agencies that a special meeting would be held if they so requested. Most of the larger urban areas had special meetings at which the highway functional classifications were discussed.

The response for the 1974 Update was very satisfactory. All counties except Madison, Fallon, Glacier, Golden Valley, Treasure, Liberty and Musselshell, and all urban-in-fact areas over 5,000 by 1990 except Dillon, Glendive, Miles City, Glasgow and Sidney responded to the request for comments. These comments are currently on file with the Planning and Research Bureau.

D. PARTICIPATION OF OTHER AGENCIES

Other agencies in addition to local county and city officials were also contacted and comments solicited. Montana has almost one third of its land in federal domain, and the federal agencies have a significant impact on the road system in the state.

The Forest Service, the Bureau of Indian Affairs, and the Bureau of Land Management were all involved in the study. These agencies thoroughly reviewed the highway functional classifications, and commented on the roads within their jurisdictional areas.

E. URBAN–IN–FACT AREAS

Urban-in-fact areas are defined as those areas with a 1990 population of 5,000 or greater inside of the urban-in-fact boundary. To be included in the urban-in-fact boundary, an area must have a population density of 1,000 or more inhabitants per square mile, or be devoted to an urban use such as airports, parks, factories, cemeteries, or the like. There are 18 urban areas that are projected to have a 1990 urban-in-fact population of 5,000 or greater.

1990 urban-in-fact boundaries were established for the 1970-1990 Study. These boundaries were reviewed in comparison to new comprehensive plans that were completed since the 1970-1990 Study, and boundaries adjusted to comply accordingly.

F. POPULATION PROJECTIONS

Since only the preliminary 1970 Census figures were available when population projections were made for the 1970-1990 Study, the county and urban-in-fact area population projections were updated for this study. The final 1970 population estimates were substantially different from the preliminary Census figures and significantly affected the population projections.

Other new data used to evaluate the population projections were a 1990 population projection done by the Division of Research and Information Systems–Department of Intergovernmental Relations, and 1971 and 1972 population estimates by county done by the U. S. Department of Commerce. Since the population projections supplied by the Information Systems Bureau were based solely on regression analysis, those counties that had been losing population would continue to lose at the same rate. This was not consistent with the assumptions made for this study; therefore, new population projections were made for 1990.

Assumptions used in projecting populations were: (1) the rural population in eastern farming regions would remain relatively stable over the planning period; (2) the urban-rural population distribution in the western mountainous counties would remain relatively constant; and (3) in general, the major population changes would occur in the urban areas.

1990 populations for the 56 counties were projected independently based upon historical popu-

lation trends and existing data on population projections for that county (such as comprehensive development plans). Population projections for all urban areas of 2,000 and over were also projected independently. Urban-rural population distributions were calculated and compared with past trends, and the population projections adjusted as necessary.

The total state population for 1990 has been held at 860,000 as provided by the Federal Highway Administration. 1990 county population estimates are shown in Table No. 1, 1990 urban-in-fact population estimates are shown in Table No. 2, and the urban-rural population distribution is shown in Table No. 3. Ranking of urban areas by population is shown in Figure No. 2.

G. TRAVEL GENERATORS

In addition to urban areas, recreation centers also generate a substantial amount of traffic. Visitation estimates for the major recreation centers within the state were obtained from the State Department of Fish and Game or, in some cases, directly from the recreation center. Projections to 1990 visitations were made from historical visitation records.

The visitation estimates were converted into equivalent population centers by means of the following equation:

$$\text{Equivalent Population} = 160 \left(\frac{\text{Visitations}}{100{,}000}\right)^{1.7}$$

Table No. 4 shows the 1972 and 1990 visitations and the equivalent population for each major recreation area.

Ranking of the equivalent populations of the recreation centers is shown with the ranking of the urban areas in Figure No. 2.

H. RURAL HIGHWAY FUNCTIONAL CLASSIFICATION

Two changes in the 1990 rural highway functional classifications had been accepted by the Montana Highway Commission since the 1970-1990 Study. These changes were to upgrade the Terry-Brockway (FAS 253) and Broadus-Biddle (FAP 54) roads from major collectors to minor arterials.

A number of other changes were suggested by county commissioners who had reviewed their functional classifications. The majority of changes came in the major collector category, since the principal arterial and minor arterial systems are relatively inflexible. The interest in major collectors was a result of the statement in the 1973 Federal-Aid Highway Act which said: *After June 30, 1976, the Federal-Aid secondary system shall consist of major collector routes.*

The Montana Department of Highways has interpreted this statement to mean that to be considered as a federal-aid secondary, the road must first be classified as a major collector. During the meetings with county commissioners this point was emphasized and, consequently, most of the response from rural local officials was in this class of roads.

TABLE NO. 1

1990 COUNTY POPULATION ESTIMATES
(Sept. 1973)

County	1970 Population	1990 Projected Population	Adjusted 1990 Population	County	1970 Population	1990 Projected Population	Adjusted 1990 Population
Beaverhead	8,187	9,919	10,300	Madison	5,014	5,107	5,300
Big Horn	10,057	9,793	10,100	Meagher	2,122	2,161	2,200
Blaine	6,727	6,764	7,000	Mineral	2,958	3,151	3,300
Broadwater	2,526	2,563	2,700	Missoula	58,263	85,506	88,400
Carbon	7,080	7,290	7,500	Musselshell	3,734	3,867	4,000
Carter	1,956	1,928	2,000	Park	11,197	11,531	11,900
Cascade	81,804	100,510	103,800	Petroleum	675	688	700
Choteau	6,473	6,437	6,700	Phillips	5,386	5,343	5,500
Custer	12,174	12,037	12,400	Pondera	6,611	6,956	7,200
Daniels	3,083	3,042	3,100	Powder River	2,862	3,155	3,300
Dawson	11,269	11,134	11,500	Powell	6,660	6,630	6,900
Deer Lodge	15,652	15,776	16,300	Prairie	1,752	1,726	1,800
Fallon	4,050	3,937	4,100	Ravalli	14,409	20,403	21,100
Fergus	12,611	12,656	13,100	Richland	9,837	9,815	10,100
Flathead	39,460	53,460	55,300	Roosevelt	10,365	10,483	10,800
Gallatin	32,505	47,338	48,900	Rosebud	6,032	6,166	6,400
Garfield	1,796	1,798	1,900	Sanders	7,093	8,016	8,300
Glacier	10,783	10,842	11,200	Sheridan	5,779	5,840	6,000
Golden Valley	931	916	900	Silver Bow	41,981	41,791	43,200
Granite	2,737	2,669	2,800	Stillwater	4,632	4,816	5,000
Hill	17,358	17,629	18,200	Sweet Grass	2,980	3,090	3,200
Jefferson	5,238	7,120	7,400	Teton	6,116	6,308	6,500
Judith Basin	2,667	2,684	2,800	Toole	5,839	5,870	6,100
Lake	14,445	17,086	17,700	Treasure	1,069	1,135	1,200
Lewis & Clark	33,281	43,645	45,100	Valley	11,471	11,736	12,100
Liberty	2,359	2,430	2,500	Wheatland	2,529	2,415	2,500
Lincoln	18,063	27,436	28,400	Wibaux	1,465	1,383	1,400
McCone	2,875	2,678	2,800	Yellowstone	87,367	115,318	119,100
TOTAL					694,345	831,923	860,000

TABLE NO. 2

1990 URBAN–IN–FACT POPULATION ESTIMATES
(Oct. 1973)

Urban-In-Fact Area	1970 Estimate	1990 Estimate	Population Change 1970-1990	Percent Change 1970-1990
1. Billings	71,235	107,000	+35,765	+50.2%
2. Great Falls	70,700	98,000	+27,300	+38.6
3. Missoula	41,720	76,500	+34,780	+83.4
4. Butte	35,290	40,000	+ 4,710	+13.3
5. Helena	23,600	38,000	+14,400	+61.0
6. Bozeman	18,138	32,000	+13,862	+76.4
7. Kalispell	14,050	25,000	+10,950	+77.9
8. Havre	11,600	13,500	+ 1.900	+16.4
9. Miles City	9,730	11,000	+ 1,270	+13.1
10. Anaconda	9,720	11,000	+ 1,280	+13.2
11. Libby	6,450	9,900	+ 3,450	+53.5
12. Livingston	7,100	7,900	+ 800	+11.3
13. Lewistown	6,700	7,600	+ 900	+13.4
14. Glendive	6,190	6,750	+ 560	+ 9.0
15. Dillon	4,660	6,150	+ 1,490	+32.0
16. Laurel	4,550	6,000	+ 1,450	+31.9
17. Glasgow	4,720	5,400	+ 680	+14.4
18. Sidney	4,700	5,100	+ 400	+ 8.5
*19. Deer Lodge	4,300	4,650	+ 350	+ 8.1
*20. Cut Bank	3,884	4,400	+ 516	+13.3
*21. Whitefish	3,500	4,300	+ 800	+22.9
*22. Hamilton	2,600	4,200	+ 1,600	+61.5
*23. Wolf Point	3,207	3,650	+ 443	+13.8
*24. Shelby	3,106	3,400	+ 294	+ 9.5
*25. Polson	2,431	3,200	+ 769	+31.6
*26. Hardin	2,758	3,100	+ 342	+12.4
*27. Conrad	2,767	2,950	+ 183	+ 6.6
*28. Baker	2,541	2,750	+ 209	+ 8.2
*29. Red Lodge	1,811	2,000	+ 189	+10.4
*30. Chinook	1,793	1,950	+ 157	+ 8.8

* Not Urban-In-Fact Areas. Projections provided for information purposes only.

TABLE NO. 3

URBAN–RURAL POPULATION DISTRIBUTION
(Oct. 1973)

	City	County	1970 County Population	1970 U-I-F Population	1970 Rural Population	1970 % Urban	1990 County Population	1990 U-I-F Population	1990 % Urban
1.	Billings	Yellowstone	87,367	71,235	*14,874	81.5	119,100	107,000	89.8
2.	Great Falls	Cascade	81,804	70,700	9,043	86.4	103,800	98,000	94.4
3.	Missoula	Missoula	58,263	41,720	16,437	71.6	88,400	76,500	86.5
4.	Butte	Silver Bow	41,981	35,290	6,366	84.1	43,200	40,000	92.6
5.	Helena	Lewis & Clark	33,281	23,600	9,349	70.9	45,100	38,000	84.3
6.	Bozeman	Gallatin	32,505	18.138	13,559	55.8	48,900	32,000	65.4
7.	Kalispell	Flathead	39,460	14,050	**24,842	35.6	55,300	25,000	45.2
8.	Havre	Hill	17,358	11,600	5,320	66.8	18,200	13,500	74.2
9.	Miles City	Custer	12,174	9,730	2,274	79.9	12,400	11,000	88.7
10.	Anaconda	Deer Lodge	15,652	9,720	5,739	62.1	16,300	11,000	67.5
11.	Libby	Lincoln	18,063	6,450	11,931	35.7	28,400	9,900	34.9
12.	Livingston	Park	11,197	7,100	3,794	63.4	11,900	7,900	66.4
13.	Lewistown	Fergus	12,611	6,700	5,481	53.1	13,100	7,600	58.0
14.	Glendive	Dawson	11,269	6,190	4,837	54.9	11,500	6,750	58.7
15.	Dillon	Beaverhead	8,187	4,660	3,388	56.9	10,300	6,150	59.7
16.	Laurel	Yellowstone	87,367	4,550	N/A	5.2	119,100	6,000	5.0
17.	Glasgow	Valley	11,471	4,720	6,318	41.1	12,100	5,400	44.6
18.	Sidney	Richland	9,837	4,700	4,900	47.8	10,100	5,100	50.5

* Includes Laurel.

** Includes Whitefish.

TABLE NO. 4

1990 RECREATION AREA VISITATION ESTIMATES
and
EQUIVALENT POPULATION AS TRAFFIC GENERATORS

Area	Visitations		Equivalent Population 1990
	1972 Actual	1990 Estimated	
Yellowstone	2,246,827	3,450,000	65,800
Glacier	1,370,101	1,970,000	25,400
Big Sky	(1)	1,200,000	13,580(2)
Custer	387,717	550,000	2,920
Big Horn Canyon	220,316	340,000(3)	1,300
Flathead	185,000	305,000(3)	1,100
Canyon Ferry	165,000	253,340(3)	780
Lewis & Clark	76,000	116,690(3)	200
Makoshika	42,000	64,486(3)	(4)
Clark Canyon	25,000	41,000(3)	(4)
Others	Data not available.		

(1) Non-existent in 1972.

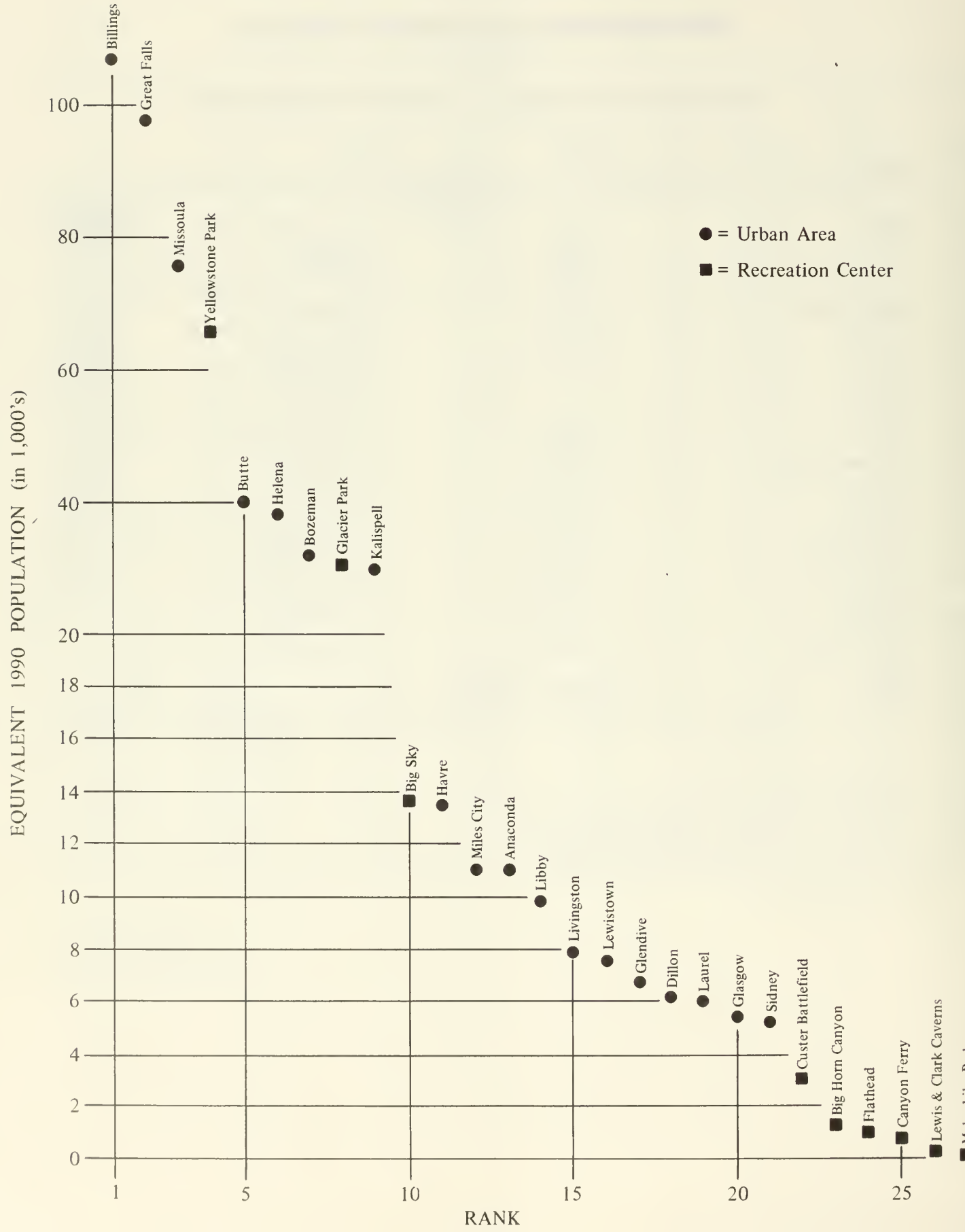
(2) Includes permanent population of 2,700.

(3) Yellowstone projection factor applied.

(4) Less than 100.

FIGURE NO. 2

RANKING OF URBAN AREAS and RECREATION CENTERS



The rural arterial routes are contained in Figure No. 3. Figure No. 4 shows all of the statewide classified systems except local roads. Detailed functional classification systems by county are available from the Planning and Research Bureau of the Department of Highways in Helena.

I. URBAN HIGHWAY FUNCTIONAL CLASSIFICATION

Urban area highway functional classifications were compared with new comprehensive plans and transportation plans that had been completed since the 1970-1990 Study, and recommendations for adjustment developed accordingly.

The urban highway functional classifications were presented to the urbanized area Technical Advisory Committees of Billings and Great Falls. These committees conducted a thorough review of the functional classifications in their areas, and recommended adjustments on several highways.

Separate presentations were made to the Cities of Missoula, Butte, Helena, Bozeman, and Kalispell; in some cases to local technical staff and in some cases to the city commissions. Reviews by these cities and responses from them were incorporated into the highway functional classifications.

Response from the smaller communities was not quite as good. However, they were all contacted and offered the opportunity to review and comment on their highway functional classifications. The lack of response was interpreted as concurrence in the classified systems established for communities not responding. Since smaller communities are not as dynamic and changing as the larger communities mentioned above it is felt that this assumption is reasonably correct, and that very little change from the functional classification established in the 1970-1990 Study has occurred.

Maps of the functional classifications in the 18 urban areas projected to be over 5,000 population by 1990 are available from the Planning and Research Bureau, Department of Highways in Helena.

J. MILEAGE AND TRAVEL

(1) Rural

(a) Mileage

The classified rural systems of principal arterial, minor arterial, and major collector were 100% inventoried. The mileage obtained from the field inventory was compared with the Federal-Aid Road Log (or the Department of Highway's local road inventory if not on a FAP or FAS system) on a section-by-section basis and adjusted as necessary. The classified mileage in the rural area consequently agrees with the state's records by route. Rural minor collector miles were obtained from the Department of Highways local road inventory by county.

Certain assumptions were made in determining rural local road mileages. These as-

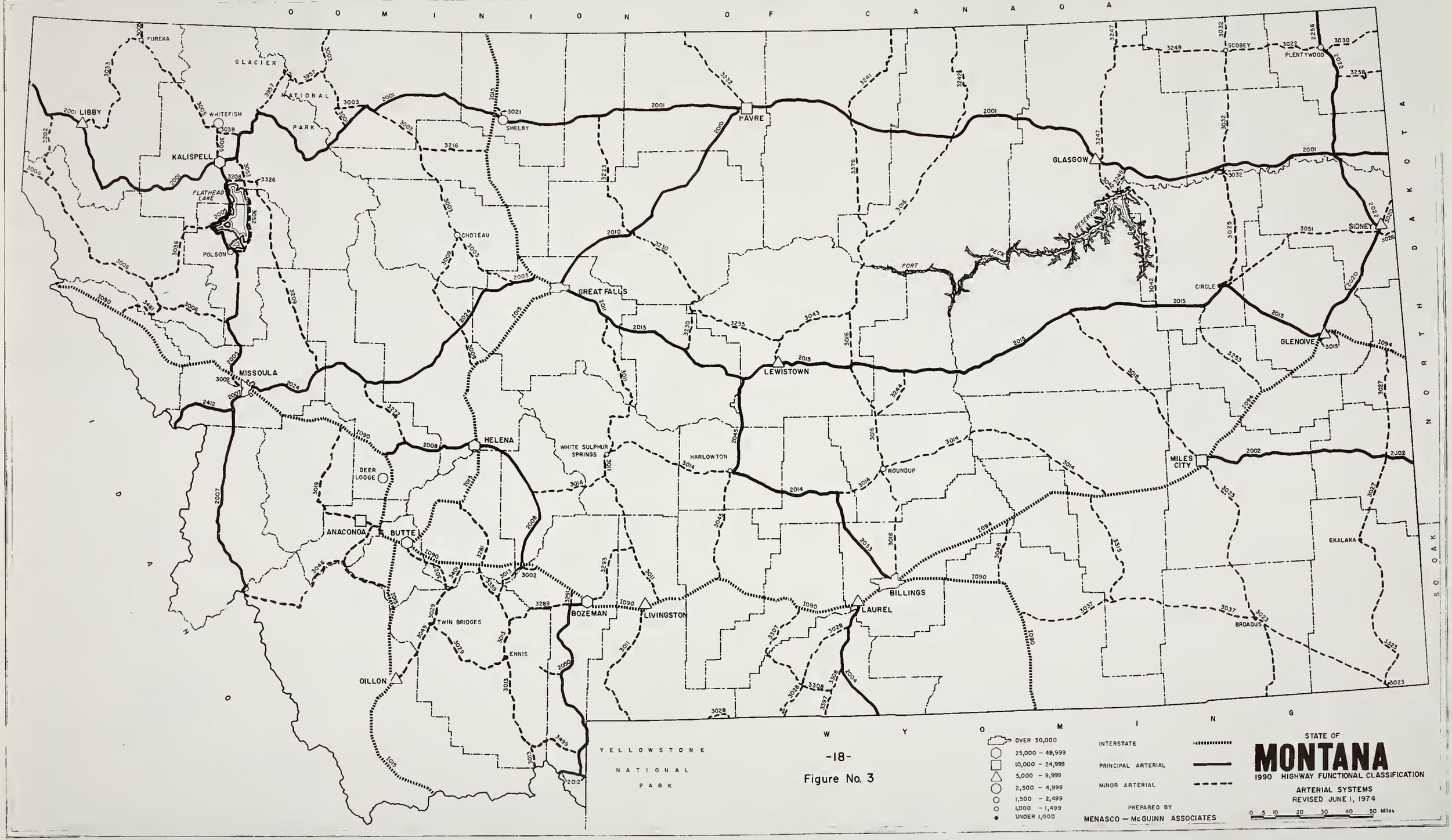

LIBBY
KALISPELL
WHITEFISH
FLATHEAD LAKE
POLSON
MISSOULA
GLACIER NATIONAL PARK
SHELBY
CHOTEAU
HAVRE
GREAT FALLS
HELENA
WHITE SULPHUR SPRINGS
HARLOWTON
LEWISTOWN
ROUNDUP
GLASGOW
SCOBEY
PLENTYWOOD
SIDNEY
FORT PECK RESERVOIR
CIRCLE
GLENDIVE
MILES CITY
DEER LODGE
ANACONDA
BUTTE
TWIN BRIDGES
ENNIS
OILLON
BOZEMAN
LIVINGSTON
BILLINGS
LAUREL
BROADUS
EKALAKA
YELLOWSTONE NATIONAL PARK
OVER 50,000
25,000 - 49,999
10,000 - 24,999
5,000 - 9,999
2,500 - 4,999
1,500 - 2,499
1,000 - 1,499
UNDER 1,000
INTERSTATE
PRINCIPAL ARTERIAL
MINOR ARTERIAL
PREPARED BY
MENASCO — McGUINN ASSOCIATES
STATE OF
MONTANA
1990 HIGHWAY FUNCTIONAL CLASSIFICATION
ARTERIAL SYSTEMS
REVISED JUNE 1, 1974
0 5 10 20 30 40 50 Miles

Figure No. 3

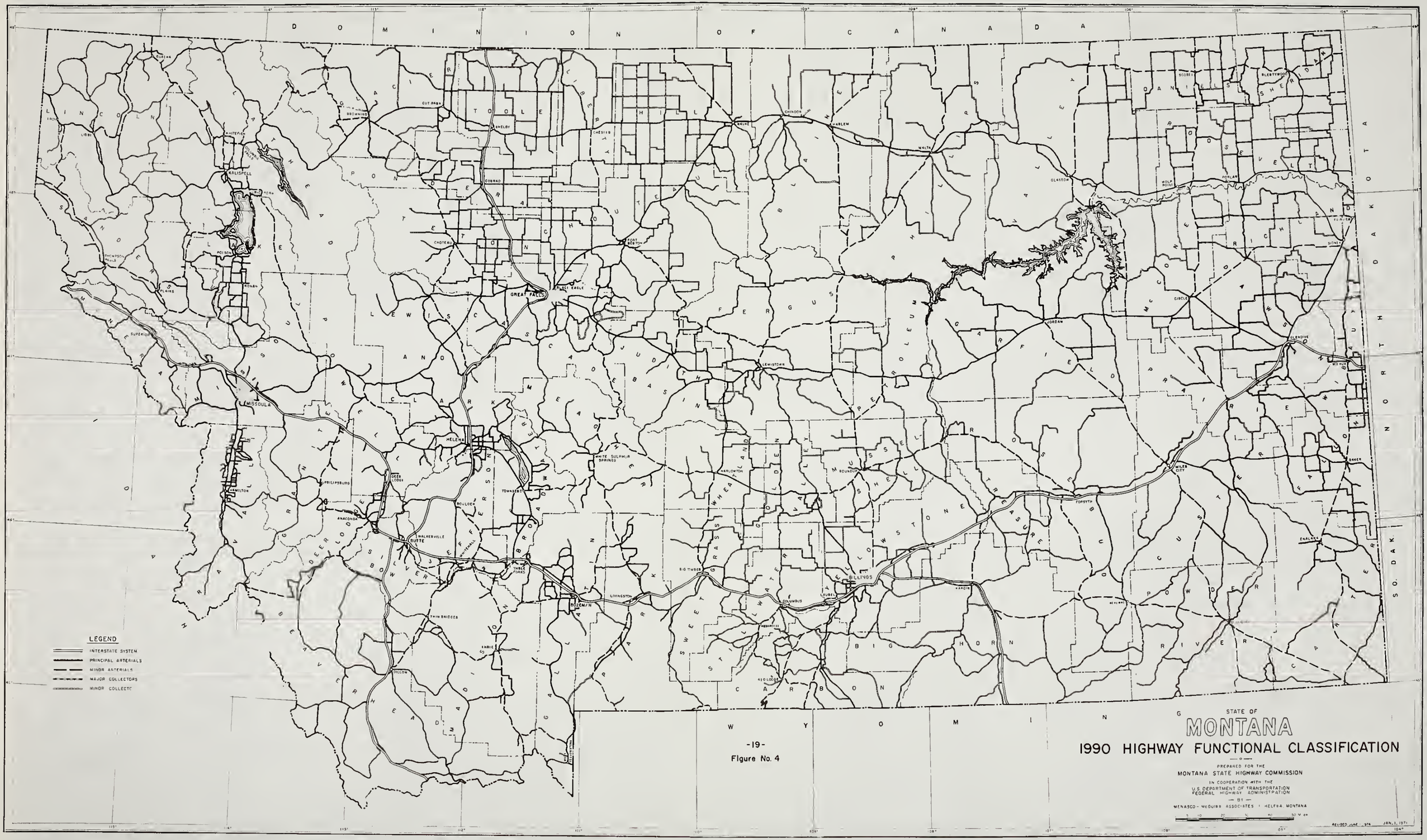

LEGEND
INTERSTATE SYSTEM
PRINCIPAL ARTERIALS
MINOR ARTERIALS
MAJOR COLLECTORS
MINOR COLLECTC
STATE OF
MONTANA
1990 HIGHWAY FUNCTIONAL CLASSIFICATION
PREPARED FOR THE
MONTANA STATE HIGHWAY COMMISSION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
BY
MENASCO - McGUIRE ASSOCIATES : HELENA MONTANA
REVISED JUNE 1974 JAN. 1, 1971

Figure No. 4

sumptions were that the rural local road mileage will remain constant over the study period (the trend of losing local road mileage will offset new roads from rural subdivisions) except for new mileage generated by construction of the interstate system.

The steps used to determine the 1990 rural local road mileage are as follows:

1. 1972 county-wide road mileages were tabulated by county from the Federal-Aid Road Log.
2. Existing 1972 road and street mileages inside of the 1990 urban-in-fact boundary were subtracted from the 1972 county road mileages, leaving 1972 rural miles.
3. New mileages due to interstate frontage roads and retained primary along interstate routes were developed.
4. The new mileages were added to the 1972 rural mileages to obtain 1990 rural mileages by county.

The development of the rural local road mileage is shown in Table No. 5.

(b) Travel

For the classified systems of principal arterial, minor arterial, and major collector that were 100% inventoried, current and projected traffic was coded for each section. The traffic volumes were multiplied by the section lengths to obtain the daily vehicle miles of travel by county for each functional system.

On minor collectors, the sample taken during the 1970-1990 Study (about 10% of the rural minor collector mileage) was used as a base. Current and projected traffic was applied to each section of the sample and expanded to a state-wide figure by multiplying by the ratio of the state minor collector miles to the sampled minor collector miles. The state-wide minor collector travel was then apportioned to each county according to the ratio of the rural population of each county to the state-wide rural population.

Travel on rural local roads was determined by using the average daily traffic on rural local roads from the Department of Highways TF-1 mileage and travel projection table and multiplying by the miles of local road in the state. The state-wide local road travel was then appropriated to each county in the same manner as the rural minor collectors.

Rural mileage and travel by county for each functionally classified system is shown in Table No. 7.

(2) Urban

(a) Mileage

Classified urban systems of principal arterials and minor arterials were 100% field inventoried. Of those sections that were on a FAP or FAS, the inventoried miles were compared with the Federal-Aid Road Log and adjusted to comply with the state's records.

Roads not on a FAP or FAS system were scaled from Highway Department maps and the lengths compared with the field inventory.

Mileages of urban collectors were determined by scaling from Department of Highways maps.

Urban local streets were obtained by the following process:

1. The density of roads in each urban area as they existed in 1968 was determined by dividing the 1968 street mileage by the area inside of the 1968 urban-in-fact boundaries.
2. The area inside of the 1990 urban-in-fact boundary for each urban area was measured.
3. The ratio of miles-of-road-per-square-miles-of-urban-area as determined for 1968 was applied to the 1990 urban-in-fact areas, resulting in total urban street mileages for 1990.
4. Miles of classified streets were subtracted from the total street mileages, leaving local street miles.

The assumption inherent in this process is that the density of streets will remain constant in any particular community as the area becoming urban enlarges.

The development of urban local street mileage is shown in Table No. 6.

(b) **Travel**

The urban principal arterials and minor arterials were 100% inventoried and current and projected traffic was coded on each worksheet. The vehicle miles of travel for these systems were calculated by multiplying the length of each section by the traffic volume.

A sample on urban collectors was available from the 1970-1990 Study. Current and projected traffic was coded on these worksheets and expanded to a state-wide travel figure. The state-wide travel was apportioned to each urban area according to the ratio of the urban population of each urban area to the state-wide urban population.

Travel on urban local streets was determined by using the average daily traffic on urban streets from the Department of Highway's TF-1 table, and multiplying by the miles of local road in the state. The state-wide local street travel thus calculated was apportioned to each urban area in the same manner as the urban collectors.

Mileage and travel for each urban area by functional system is shown in Table No. 8.

A summary of urban and rural mileage and travel by functional system is shown in Figure No. 9. This table also shows the average traffic volume by system and the anticipated growth of travel from 1972 to 1990.

(3) **Jurisdictional Responsibility**

Mileage and travel for each functional system for the interstate, federal-aid primary, federal-aid secondary and non-federal-aid is shown in data summary Tables No. 10, 11, 12, 13, and 14.

K. RESULTS OF HIGHWAY FUNCTIONAL CLASSIFICATION

The result of the highway functional classification part of the study is a current classification by function of urban and rural highways in Montana. This classification reflects local preferences and priorities which were obtained from meetings with the local agencies and obtaining comments. The functionally classified systems are shown on county maps and urban area maps at the office of the Planning and Research Bureau, Department of Highways. Copies of these maps can be obtained at a nominal cost from the Department of Highways.

TABLE NO. 5

DEVELOPMENT OF 1990 RURAL LOCAL ROAD MILES

County	1972		1972 to 1990	1990		
	Total County Miles[1]	Total Urban Miles[2]	New Rural Miles	Rural County Miles	Classified Miles	Rural Local Road Miles
	1	2	3	4=1-2+3	5	6=4-5
1. Beaverhead	1,549.9	27.0	7.3	1,530.2	663.5	866.7
2. Big Horn	1,368.2		85.8	1,454.0	581.9	872.1
3. Blaine	1,684.2			1,684.2	535.1	1,149.1
4. Broadwater	831.1			831.1	231.1	600.0
5. Carbon	1,002.1		7.4	1,009.5	451.6	557.9
6. Carter	899.9			899.9	395.6	504.3
7. Cascade	2,059.3	304.0		1,755.3	627.3	1,128.0
8. Chouteau	2,458.7			2,458.7	755.0	1,703.7
9. Custer	1,162.7	72.5		1,090.2	464.6	625.6
10. Daniels	879.3			879.3	283.8	595.5
11. Dawson	1,205.1	40.9	5.8	1,170.0	449.9	720.1
12. Deer Lodge	333.8	28.2	10.5	316.1	149.9	166.2
13. Fallon	923.0			923.0	326.8	596.2
14. Fergus	1,901.7	50.3		1,851.4	638.5	1,212.9
15. Flathead	2,124.5	91.0	11.5	2,045.0	680.1	1,364.9
16. Gallatin	1,602.6	88.6		1,514.0	482.6	1,031.4
17. Garfield	1,284.7			1,284.7	532.4	752.3
18. Glacier	1,026.6			1,026.6	482.3	544.3
19. Golden Valley	638.5			638.5	238.0	400.5
20. Granite	674.3			674.3	227.6	446.7
21. Hill	2,324.0	54.2	6.5	2,276.3	687.9	1,588.4
22. Jefferson	772.0		29.0	801.0	345.0	456.0
23. Judith Basin	1,078.7			1,078.7	295.5	783.2
24. Lake	1,291.3			1,291.3	366.0	925.3
25. Lewis & Clark	1,557.4	177.9		1,379.5	600.7	778.8
26. Liberty	955.5			955.5	298.4	657.1
27. Lincoln	1,987.8	51.4		1,936.4	621.6	1,314.8
28. McCone	1,412.5			1,412.5	443.2	969.3
29. Madison	1,411.0		7.3	1,418.3	448.6	969.7
30. Meagher	805.6			805.6	291.9	513.7
31. Mineral	981.5		8.3	989.8	221.8	768.0
32. Missoula	1,781.9	268.1		1,513.8	381.6	1,132.2
33. Musselshell	1,001.4			1,001.4	359.5	641.9
34. Park	1,057.3	40.9	15.9	1,032.3	373.1	659.2
35. Petroleum	569.4			569.4	208.4	361.0
36. Phillips	1,694.6			1,694.6	612.2	1,082.4
37. Pondera	1,091.2			1,091.2	372.1	719.1
38. Powder River	1,062.0			1,062.0	475.3	586.7
39. Powell	956.8		10.7	967.5	265.1	702.4
40. Prairie	789.0		3.0	792.0	250.0	542.0
41. Ravalli	1,405.6			1,405.6	363.8	1,041.8
42. Richland	1,389.5	37.3		1,352.2	419.1	933.1
43. Roosevelt	1,589.4			1,589.4	529.7	1,059.7
44. Rosebud	1,603.4		5.5	1,608.9	628.1	980.8
45. Sanders	1,633.7			1,633.7	479.0	1,154.7
46. Sheridan	1,314.5			1,314.5	419.0	895.5
47. Silver Bow	534.6	262.6	29.6	301.6	104.2	197.4
48. Stillwater	1,023.0			1,023.0	349.5	673.5
49. Sweet Grass	632.3		34.2	666.5	316.7	349.8
50. Teton	1,460.2		14.6	1,474.8	463.5	1,011.3
51. Toole	1,288.9		21.4	1,310.3	445.2	865.1
52. Treasure	390.8			390.8	157.6	233.2
53. Valley	2,065.3	35.9		2,029.4	539.6	1,489.8
54. Wheatland	549.4			549.4	209.8	339.6
55. Wibaux	528.0			528.0	185.9	342.1
56. Yellowstone	2,040.1	427.8	35.3	1,647.6	528.4	1,119.2
TOTAL	69,639.8	2,058.6	349.6	67,930.8	23,254.6	44,676.2

(1) Does not include Type "A" Primitive Roads.
(2) Miles within the 1990 U.I.F. Boundary.

TABLE NO. 6

DEVELOPMENT OF 1990 URBAN LOCAL STREET MILES

Urban Area	1968			1990			
	U.I.F. Area (Sq.Mi.)	Road Miles	Mi./Sq.Mi.	U.I.F. Area (Sq.Mi.)	Total Road Miles	Classified Miles	Local Street Miles
	1	2	3	4	5=4x3	6	7=5-6
1. Billings	27.74	320.70	11.56	54.35	628.29	183.50	444.79
2. Great Falls	24.45	277.30	11.34	37.23	422.19	118.80	303.39
3. Missoula ...	18.65	234.00	12.55	42.84	537.64	117.20	420.44
4. Butte	14.82	169.30	11.42	25.62	292.58	75.00	217.58
5. Helena	9.52	145.49	15.28	18.17	277.64	70.40	207.24
6. Bozeman ..	4.45	76.45	17.18	11.15	191.56	44.00	147.56
7. Kalispell ...	8.64	72.74	8.42	15.33	129.08	44.90	84.19
8. Havre	3.72	55.95	15.04	4.27	64.22	18.40	45.82
9. Miles City..	4.58	63.86	13.94	4.76	72.50(1)	19.30	53.20
10. Anaconda..	3.42	29.91	8.75	4.24	37.10	14.40	22.70
11. Libby.....	5.13	48.78	9.51	5.84	55.54	19.80	35.74
12. Livingston.	2.20	40.02	18.19	2.62	47.66	12.40	35.26
13. Lewistown	5.38	49.02	9.11	6.23	56.76	19.30	37.46
14. Glendive ...	2.45	27.39	11.18	3.93	43.94	14.10	29.84
15. Dillon	1.17(2)	27.02(3)	23.09	1.73	39.95	8.60	31.35
16. Laurel	2.33	32.11	13.78	2.70	37.21	13.70	23.51
17. Glasgow	3.70	33.80	9.14	4.69	42.87	11.60	31.27
18. Sidney	1.28	24.20(3)	18.91	2.64(4)	49.92	13.70	36.22

(1) Projected miles from 1968 data were less than the measured 1972 existing miles. Therefore, 1972 existing miles were used for Miles City.

(2) Does not include swamp area inside Urban-In-Fact (U.I.F.) boundary.

(3) These figures are 1972 municipal miles since these areas were not urban in the 1968 Study.

(4) Does not include public area on west side.

TABLE NO. 7

RURAL MILEAGE AND TRAVEL BY COUNTY

County	INTERSTATE						PRINCIPAL ARTERIAL						MINOR ARTERIAL					
	1990				1972		1990				1972		1990				1972	
	Miles	%	DVM	%	DVM	%	Miles	%	DVM	%	DVM	%	Miles	%	DVM	%	DVM	%
1. Beaverhead	85.3	5.6	133,905	51.0	88,344	53.6	0	0	0	0	0	0	71.8	4.7	57,573	21.9	28,418	17.3
2. Big Horn	79.8	5.5	272,380	42.6	162,020	46.4	0	0	0	0	0	0	63.1	4.3	97,254	15.2	47,237	13.5
3. Blaine	0	0	0	0	0	0	54.4	3.2	144,411	56.2	84,853	51.0	82.9	4.9	33,865	13.2	19,898	11.9
4. Broadwater	5.7	0.7	26,495	11.2	17,049	12.2	51.9	6.2	151,333	64.2	81,504	58.1	29.6	3.6	25,706	10.9	16,207	11.6
5. Carbon	0	0	0	0	0	0	50.8	5.0	137,355	39.3	80,706	36.2	117.4	11.6	136,171	39.0	80,552	36.2
6. Carter	0	0	0	0	0	0	0	0	0	0	0	0	122.2	13.6	71,236	74.9	36,108	65.9
7. Cascade	55.3	3.2	246,910	36.9	146,797	34.3	67.3	3.8	256,388	38.3	129,304	30.2	54.9	3.1	53,509	8.0	31,441	7.3
8. Chouteau	0	0	0	0	0	0	73.1	3.0	144,847	56.9	85,107	49.4	71.7	2.9	31,033	12.2	18,750	10.9
9. Custer	42.8	3.9	122,995	52.2	81,488	49.5	45.4	4.2	28,947	12.3	20,164	12.3	70.8	6.5	53,617	22.7	35,281	21.4
10. Daniels	0	0	0	0	0	0	0	0	0	0	0	0	81.7	9.3	39,082	56.8	24,153	46.7
11. Dawson	43.7	3.7	140,960	48.7	82,064	43.9	35.4	3.0	38,026	13.1	22,346	12.0	47.6	4.1	50,607	17.5	27,654	14.8
12. Deer Lodge	14.3	4.5	86,485	37.9	47,575	33.0	0	0	0	0	0	0	57.6	18.2	65,104	28.5	38,323	26.5
13. Fallon	0	0	0	0	0	0	43.8	4.7	43,679	35.5	30,583	35.0	42.6	4.6	38,040	30.9	20,488	23.4
14. Fergus	0	0	0	0	0	0	70.8	3.8	101,914	37.9	59,880	33.9	150.2	8.1	96,334	35.8	55,531	31.4
15. Flathead	0	0	0	0	0	0	127.2	6.2	381,318	32.1	205,440	30.8	124.5	6.1	427,779	36.1	208,608	31.2
16. Gallatin	40.5	2.7	312,690	31.6	164,052	32.3	98.6	6.5	323,146	32.7	132,673	26.1	80.8	5.3	104,826	10.6	47,494	9.4
17. Garfield	0	0	0	0	0	0	89.3	6.9	46,432	52.1	27,286	47.3	46.9	3.7	16,014	18.0	9,416	16.3
18. Glacier	0	0	0	0	0	0	66.5	6.5	166,649	33.0	90,478	29.8	101.0	9.8	171,667	34.0	89,337	29.4
19. Golden Valley	0	0	0	0	0	0	36.0	5.6	53,001	79.2	32,919	73.3	5.6	0.9	2,430	3.6	1,557	3.5
20. Granite	28.7	4.3	140,440	55.7	89,383	61.2	0	0	0	0	0	0	36.1	5.3	31,303	12.4	18,395	12.6
21. Hill	0	0	0	0	0	0	76.9	3.4	209,421	69.4	116,417	59.1	42.4	1.8	12,957	4.3	9,152	4.6
22. Jefferson	95.4	11.9	308,790	65.8	189,015	67.1	1.5	0.2	6,192	1.3	3,335	1.2	76.8	9.6	77,657	16.6	38,926	13.8
23. Judith Basin	0	0	0	0	0	0	61.3	5.7	125,069	76.5	73,486	70.3	16.4	1.5	6,252	3.8	3,674	3.5
24. Lake	0	0	0	0	0	0	78.2	6.1	371,329	55.8	200,020	51.4	71.1	5.5	122,059	18.3	62,940	16.2
25. Lewis & Clark	43.4	3.1	129,885	25.9	87,627	27.7	70.9	5.1	207,617	41.3	101,409	32.0	43.3	3.1	25,469	5.1	13,720	4.3
26. Liberty	0	0	0	0	0	0	25.6	2.7	44,347	53.4	23,883	47.3	27.3	2.9	10,262	12.3	5,526	10.9
27. Lincoln	0	0	0	0	0	0	73.4	3.8	165,463	32.1	89,102	29.8	118.8	6.1	155,606	30.2	85,055	28.4
28. McCone	0	0	0	0	0	0	87.7	6.2	80,539	63.4	47,334	57.9	72.5	5.1	16,183	12.7	9,533	11.7
29. Madison	7.4	0.5	11,100	4.1	5,232	3.3	0	0	0	0	0	0	191.3	13.5	210,496	77.4	113,690	72.7
30. Meagher	0	0	0	0	0	0	0	0	0	0	0	0	101.9	12.6	64,367	72.2	39,901	64.6
31. Mineral	76.8	7.8	316,145	84.6	190,494	83.5	0	0	0	0	0	0	7.7	0.8	4,935	1.3	2,667	1.2
32. Missoula	46.9	3.1	308,065	33.9	181,172	33.0	95.2	6.3	378,830	41.6	181,588	33.0	55.4	3.7	95,515	10.5	46,682	8.5
33. Musselshell	0	0	0	0	0	0	0	0	0	0	0	0	101.4	10.1	122,991	77.9	24,917	45.8
34. Park	32.0	3.1	175,345	46.9	102,810	45.5	0	0	0	0	0	0	112.8	10.9	147,212	39.4	82,167	36.4
35. Petroleum	0	0	0	0	0	0	35.0	6.2	18,599	51.0	10,930	45.8	27.8	4.9	10,572	29.0	6,652	27.9
36. Phillips	0	0	0	0	0	0	55.1	3.3	108,666	51.0	63,850	46.1	134.3	7.9	52,028	24.4	29,822	21.5
37. Pondera	30.6	2.8	105,505	41.3	53,676	33.4	0	0	0	0	0	0	49.4	4.5	46,633	18.3	27,416	17.1
38. Powder River	0	0	0	0	0	0	0	0	0	0	0	0	119.7	11.3	106,550	74.7	56,523	67.1
39. Powell	34.2	3.5	191,595	46.1	110,288	44.7	57.4	6.0	140,171	33.8	69,306	28.1	32.6	3.4	12,565	3.0	7,367	3.0
40. Prairie	27.8	3.5	89,100	77.0	53,998	73.7	0	0	0	0	0	0	36.9	4.7	3,945	3.4	2,747	3.8
41. Ravalli	0	0	0	0	0	0	76.8	5.5	321,397	55.5	145,208	48.9	0.1	0.0	40	0.0	20	0.0
42. Richland	0	0	0	0	0	0	0	0	0	0	0	0	117.3	8.7	170,336	75.4	93,853	66.0
43. Roosevelt	0	0	0	0	0	0	92.4	5.8	159,412	50.8	100,288	45.2	55.2	3.5	41,776	13.3	24,547	11.1
44. Rosebud	41.8	2.6	153,180	30.8	92,628	39.8	0	0	0	0	0	0	158.9	9.9	239,607	48.3	82,784	35.6
45. Sanders	0	0	0	0	0	0	0	0	0	0	0	0	176.3	10.8	216,393	73.5	117,282	65.4
46. Sheridan	0	0	0	0	0	0	0	0	0	0	0	0	112.6	8.6	95,918	62.5	56,868	53.7
47. Silver Bow	42.8	14.2	178,230	80.3	107,655	64.0	0	0	0	0	0	0	12.1	4.0	9,885	4.5	5,780	3.4
48. Stillwater	38.3	3.7	204,785	68.0	129,582	65.6	0	0	0	0	0	0	22.9	2.2	32,664	10.8	19,132	9.7
49. Sweet Grass	37.1	5.6	176,710	67.4	108,062	66.9	0	0	0	0	0	0	31.5	4.7	28,447	10.9	16,353	10.1
50. Teton	21.4	1.5	67,140	29.1	48,852	29.7	0	0	0	0	0	0	69.5	4.7	81,425	35.3	47,041	28.6
51. Toole	43.8	3.3	89,370	35.2	48,029	30.6	43.8	3.3	93,324	36.7	50,256	32.0	0	0	0	0	0	0
52. Treasure	26.2	6.7	78,980	78.3	51,829	79.3	0	0	0	0	0	0	0	0	0	0	0	0
53. Valley	0	0	0	0	0	0	77.5	3.8	153,795	52.8	90,365	45.9	105.7	5.2	71,395	24.5	47,734	24.2
54. Wheatland	0	0	0	0	0	0	40.5	7.4	51,624	48.6	31,882	44.4	39.2	7.1	30,777	29.0	19,256	26.8
55. Wibaux	15.3	2.9	53,495	56.5	27,596	49.6	0	0	0	0	0	0	25.8	4.9	23,118	24.4	12,475	22.4
56. Yellowstone	81.2	4.9	366,390	47.1	238,760	47.5	29.4	1.8	64,969	8.4	38,174	7.6	26.3	1.6	39,266	5.0	22,785	4.5
Totals	1,138.5	1.7	4,487,070	25.0	2,706,077	24.8	1,989.1	2.9	4,718,210	26.3	2,520,076	23.2	3,852.2	5.7	3,988,451	22.2	2,089,835	19.2

County	MAJOR COLLECTOR						MINOR COLLECTOR						LOCAL ROAD						TOTAL SYSTEM					
	1990				1972		1990				1972		1990				1972		1990				1972	
	Miles	%	DVM	%	DVM	%	Miles	%	DVM	%	DVM	%	Miles	%	DVM	%	DVM	%	Miles	%	DVM	%	DVM	%
1. Beaverhead	163.9	10.7	40,471	15.4	22,249	13.5	342.5	22.4	7,726	3.0	5,517	3.3	866.7	56.6	22,803	8.7	20,208	12.3	1,530.2	2.2	262,478	1.5	164,736	1.5
2. Big Horn	238.9	16.4	192,600	30.1	66,139	19.0	200.1	13.8	21,710	3.4	15,786	4.5	872.1	60.0	55,238	8.7	57,824	16.6	1,454.0	2.1	639,182	3.6	349,006	3.2
3. Blaine	136.8	8.1	21,193	8.2	12,611	7.6	261.0	15.5	18,901	7.4	10,542	6.3	1,149.1	68.3	38,764	15.0	38,616	23.2	1,684.2	2.5	257,134	1.4	166,520	1.5
4. Broadwater	45.5	5.5	12,316	5.2	6,962	4.9	98.4	11.8	5,309	2.3	3,988	2.8	600.0	72.2	14,743	6.2	14,606	10.4	831.1	1.2	235,902	1.3	140,316	1.3
5. Carbon	107.7	10.7	19,120	5.5	9,760	4.4	175.7	17.4	15,538	4.4	11,089	5.0	557.9	55.3	41,084	11.8	40,617	18.2	1,009.5	1.5	349,268	1.9	222,724	2.0
6. Carter	112.5	12.5	7,036	7.4	4,454	8.1	160.9	17.9	5,780	6.1	3,059	5.6	504.3	56.0	11,008	11.6	11,205	20.4	899.9	1.3	95,060	0.5	54,826	0.5
7. Cascade	160.6	9.1	60,449	9.0	39,359	9.2	289.2	16.5	14,458	2.1	17,425	4.1	1,128.0	64.3	38,190	5.7	63,826	14.9	1,755.3	2.6	669,904	3.7	428,152	3.9
8. Chouteau	209.1	8.5	30,344	11.9	21,105	12.2	401.1	16.3	11,712	4.6	10,160	5.9	1,703.7	69.3	36,760	14.4	37,215	21.6	2,458.7	3.6	254,696	1.4	172,337	1.6
9. Custer	149.3	13.7	14,161	6.0	9,874	6.0	156.3	14.3	8,084	3.4	3,824	2.3	625.6	57.4	7,925	3.4	14,006	8.5	1,090.2	1.6	235,729	1.3	164,637	1.5
10. Daniels	42.1	4.8	7,551	11.0	4,923	9.5	160.0	18.2	5,314	7.7	4,861	9.4	595.5	67.7	16,905	24.5	17,807	34.4	879.3	1.3	68,852	0.4	51,744	0.5
11. Dawson	129.2	11.1	25,098	8.7	17,736	9.5	194.0	16.6	8,889	3.1	7,975	4.2	720.1	61.6	25,948	9.0	29,212	15.6	1,170.0	1.7	289,528	1.6	186,987	1.7
12. Deer Lodge	33.3	10.5	36,464	16.0	15,185	10.5	44.7	14.2	10,738	4.7	9,286	6.4	166.2	52.6	29,422	12.9	34,014	23.6	316.1	0.5	228,213	1.3	144,383	1.3
13. Fallon	93.8	10.2	9,892	8.0	6,865	7.8	146.6	15.9	9,174	7.4	6,336	7.3	596.2	64.6	22,410	18.2	23,210	26.5	923.0	1.4	123,195	0.7	87,482	0.8
14. Fergus	140.7	7.6	27,023	10.1	18,027	10.2	276.8	15.0	13,549	5.0	9,286	5.3	1,212.9	65.5	30,076	11.2	34,014	19.2	1,851.4	2.7	268,896	1.5	176,738	1.6
15. Flathead	137.9	6.7	137,642	11.6	67,395	10.1	290.5	14.2	73,056	6.2	39,875	6.0	1,364.9	66.8	165,910	14.0	146,060	21.9	2,045.0	3.0	1,185,705	6.6	667,378	6.1
16. Gallatin	127.7	8.4	104,149	10.5	58,408	11.5	135.0	8.9	52,491	5.3	22,560	4.4	1,031.4	68.1	92,390	9.3	82,634	16.3	1,514.0	2.2	989,692	5.5	507,821	4.7
17. Garfield	159.9	12.4	12,522	14.1	7,715	13.4	236.3	18.4	3,653	4.1	2,840	4.9	752.3	58.6	10,419	11.7	10,404	18.1	1,284.7	1.9	89,040	0.5	57,661	0.5
18. Glacier	152.5	14.9	73,518	14.6	44,494	14.7	162.3	15.8	31,473	6.2	16,933	5.6	544.3	53.0	61,332	12.2	62,026	20.5	1,026.6	1.5	504,639	2.8	303,268	2.8
19. Golden Valley	53.4	8.4	5,034	7.5	3,553	7.9	143.0	22.4	1,545	2.3	1,475	3.3	400.5	62.7	4,914	7.4	5,402	12.0	638.5	0.9	66,924	0.4	44,906	0.4
20. Granite	108.5	16.1	46,940	18.6	18,411	12.6	54.3	8.0	6,724	2.7	4,261	2.9	446.7	66.3	26,708	10.6	15,606	10.7	674.3	1.0	252,115	1.4	146,056	1.3
21. Hill	227.4	10.0	45,186	15.0	29,426	14.9	341.2	15.0	8,515	2.8	9,013	4.6	1,588.4	69.8	25,751	8.5	33,014	16.8	2,276.3	3.4	301,830	1.7	197,022	1.8
22. Jefferson	59.3	7.4	20,339	4.3	12,290	4.4	112.0	14.0	15,736	3.4	8,194	2.9	456.0	56.9	40,495	8.6	30,012	10.6	801.0	1.2	469,209	2.6	281,772	2.6
23. Judith Basin	86.0	8.0	11,539	7.1	7,717	7.4	131.8	12.2	5,288	3.2	4,206	4.0	783.2	72.6	15,333	9.4	15,406	14.8	1,078.7	1.6	163,481	0.9	104,489	1.0
24. Lake	59.0	4.6	32,602	4.9	20,554	5.3	157.7	12.2	41,517	6.2	22,669	5.8	925.3	71.6	98,777	14.8	83,034	21.3	1,291.3	1.9	666,284	3.7	389,217	3.6
25. Lewis & Clark	145.5	10.6	75,694	15.1	43,430	13.7	297.6	21.6	24,560	4.9	15,185	4.8	778.8	56.5	38,922	7.7	55,623	17.5	1,379.5	2.0	502,147	2.8	316,994	2.9
26. Liberty	84.5	8.8	5,386	6.5	3,766	7.5	161.0	16.8	9,303	11.2	3,714	7.4	657.1	68.8	13,760	16.6	13,606	26.9	955.5	1.4	83,058	0.5	50,495	0.5
27. Lincoln	172.6	8.9	56,716	11.0	40,166	13.4	256.8	13.3	36,179	7.0	18,244	6.1	1,314.8	67.9	101,236	19.7	66,828	22.3	1,936.4	2.9	515,200	2.9	299,395	2.8
28. McCone	59.3	4.2	5,469	4.3	3,637	4.5	223.7	15.9	9,572	7.5	4,534	5.6	969.3	68.6	15,333	12.1	16,607	20.3	1,412.5	2.1	127,096	0.7	81,645	0.8
29. Madison	111.1	0.8	1,278	0.5	878	0.6	238.8	16.8	19,943	7.3	7,866	5.0	969.7	68.4	29,093	10.7	28,812	18.4	1,418.3	2.1	271,910	1.5	156,478	1.4
30. Meagher	52.9	6.6	9,000	10.1	6,301	10.2	137.1	17.0	3,769	4.2	3,332	5.4	513.7	63.8	11,991	13.5	12,205	19.8	805.6	1.2	89,127	0.5	61,739	0.6
31. Mineral	47.7	4.8	26,382	7.1	13,228	5.8	89.6	9.0	8,124	2.2	4,643	2.0	768.0	77.6	18,085	4.8	17,007	7.5	989.8	1.5	373,671	2.1	228,039	2.1
32. Missoula	63.8	4.2	36,714	4.0	18,954	3.5	120.3	7.9	25,291	2.8	25,946	4.7	1,132.2	74.8	65,066	7.2	95,039	17.3	1,513.8	2.2	909,481	5.1	549,381	5.1
33. Musselshell	52.7	5.3	3,712	2.4	2,270	4.2	205.4	20.5	9,349	5.9	5,845	10.7	641.9	64.1	21,820	13.8	21,409	39.3	1,001.4	1.5	157,872	0.9	54,441	0.5
34. Park	89.2	8.6	16,435	4.4	10,771	4.8	139.1	13.5	12,794	3.4	6,446	2.8	659.2	63.9	21,820	5.9	23,610	10.5	1,032.3	1.5	373,606	2.1	225,804	2.1
35. Petroleum	64.5	11.3	2,099	5.8	1,428	6.0	81.1	14.2	1,236	3.4	1,038	4.4	361.0	63.4	3,932	10.8	3,802	15.9	569.4	0.8	36,438	0.2	23,850	0.2
36. Phillips	53.3	3.1	9,675	4.5	5,405	3.9	369.5	21.8	12,766	6.0	8,467	6.1	1,082.4	63.9	30,076	14.1	31,013	22.4	1,694.6	2.5	213,211	1.2	138,557	1.3
37. Pondera	137.8	12.6	48,559	19.0	31,018	19.3	154.3	14.2	15,267	6.0	10,378	6.5	719.1	65.9	39,315	15.4	38,015	23.7	1,091.2	1.6	255,279	1.4	160,503	1.5
38. Powder River	114.6	10.8	11,078	7.8	6,838	8.1	241.0	22.7	6,846	4.8	4,479	5.3	586.7	55.2	18,085	12.7	16,407	19.5	1,062.0	1.6	142,559	0.8	84,247	0.8
39. Powell	21.8	2.3	18,101	4.4	10,993	4.5	119.1	12.3	14,806	3.6	10,433	4.2	702.4	72.5	37,742	9.1	38,216	15.5	967.5	1.4	414,980	2.3	246,603	2.3
40. Prairie	55.9	7.0	5,471	4.7	3,818	5.2	129.4	16.3	3,090	2.7	2,731	3.7	542.0	68.5	14,098	12.2	10,004	13.6	792.0	1.2	115,704	0.6	73,298	0.7
41. Ravalli	86.4	6.1	79,030	13.7	46,378	15.6	200.5	14.3	61,367	10.6	22,614	7.6	1,041.8	74.1	117,191	20.2	82,834	27.9	1,405.6	2.1	579,025	3.2	297,054	2.7
42. Richland	154.8	11.4	19,565	8.7	10,610	7.5	147.0	10.9	8,589	3.8	8,084	5.7	933.1	69.0	27,324	12.1	29,612	20.8	1,352.2	2.0	225,814	1.3	142,159	1.3
43. Roosevelt	178.1	11.2	30,740	9.8	20,983	9.5	204.0	12.8	22,645	7.2	16,278	7.3	1,059.7	66.7	59,169	18.9	59,625	26.9	1,589.4	2.3	313,742	1.7	221,721	2.0
44. Rosebud	151.6	9.4	52,822	10.6	13,041	5.6	275.8	17.1	12,700	2.6	9,450	4.1	980.8	61.0	38,219	7.7	34,614	14.9	1,608.9	2.4	496,528	2.8	232,517	2.1
45. Sanders	79.0	4.8	18,359	6.2	10,123	5.6	223.7	13.7	14,274	4.9	11,143	6.2	1,154.7	70.7	45,409	15.4	40,817	22.8	1,633.7	2.4	294,435	1.6	179,365	1.7
46. Sheridan	89.5	6.8	10,723	7.0	6,674	6.3	216.9	16.5	13,910	9.1	9,067	8.6	895.5	68.1	32,828	21.4	33,214	31.4	1,314.5	1.9	153,379	0.9	105,823	1.0
47. Silver Bow	23.5	7.8	8,876	4.0	5,795	3.5	25.8	8.5	7,377	3.3	10,488	6.2	197.4	65.5	17,495	7.9	38,416	22.9	301.6	0.4	221,863	1.2	168,134	1.5
48. Stillwater	120.6	11.8	21,537	7.2	14,755	7.5	167.7	16.4	13,037	4.3	7,265	3.7	673.5	65.9	29,049	9.7	26,611	13.5	1,023.0	1.5	301,072	1.7	197,345	1.8
49. Sweet Grass	91.7	13.7	28,361	10.8	15,267	9.4	156.4	23.5	10,993	4.2	4,698	2.9	349.8	52.5	17,495	6.7	17,207	10.7	666.5	1.0	262,006	1.5	161,587	1.5
50. Teton	137.9	9.3	35,629	15.4	23,889	14.5	234.7	15.9	11,184	4.8	9,614	5.8	1,011.3	68.6	35,580	15.4	35,215	21.4	1,474.8	2.2	230,958	1.3	164,611	1.5
51. Toole	138.0	10.5	23,436	9.2	15,956	10.2	219.6	16.8	14,380	5.7	9,177	5.8	865.1	66.1	33,418	13.2	33,614	21.4	1,310.3	1.9	253,928	1.4	157,032	1.4
52. Treasure	40.6	10.4	8,922	8.9	5,584	8.6	90.8	23.2	6,404	6.4	1,693	2.6	233.2	59.7	6,487	6.4	6,203	9.5	390.8	0.6	100,793	0.6	65,309	0.6
53. Valley	95.8	4.7	15,280	5.3	9,425	4.8	260.6	12.9	13,921	4.8	10,597	5.4	1,489.8	73.4	36,760	12.6	38,816	19.7	2,029.4	3.0	291,151	1.6	196,937	1.8
54. Wheatland	36.1	6.6	3,012	2.8	1,987	2.8	94.0	17.1	7,055	6.6	3,988	5.6	339.6	61.8	13,760	13.0	14,606	20.4	549.4	0.8	106,228	0.6	71,719	0.7
55. Wibaux	64.0	12.1	7,683	8.1	4,915	8.8	80.8	15.3	2,697	2.9	2,294	4.1	342.1	64.8	7,666	8.1	8,403	15.1	528.0	0.8	94,659	0.5	55,683	0.5
56. Yellowstone	160.7	9.8	160,829	20.7	84,497	16.8	230.8	14.0	76,947	9.9	25,345	5.1	1,119.2	67.9	69,297	8.9	92,838	18.5	1,647.6	2.4	777,698	4.3	502,399	4.6
Totals	5,810.5	8.5	1,849,762	10.3	1,017,992	9.4	10,464.3	15.4	907,255	5.1	546,236	5.0	44,676.2	65.8	2,000,826	11.1	2,000,826	18.4	67,930.8	100.0	17,951,574	100.0	10,881,042	100.0

DVM = Daily Vehicle Miles of Travel.

* Does not include Type A (Primitive) Road Miles or Travel.

TABLE NO. 8

URBAN MILEAGE AND TRAVEL

	INTERSTATE						PRINCIPAL ARTERIAL						MINOR ARTERIAL					
	1990				1972		1990				1972		1990				1972	
	Miles	%	DVM	%	DVM	%	Miles	%	DVM	%	DVM	%	Miles	%	DVM	%	DVM	%
Urbanized Areas																		
1. Billings	13.0	2.1	88,880	5.1	67,148	6.5	52.4	8.3	705,248	40.7	369,684	35.8	54.1	8.6	408,096	23.5	151,678	14.7
2. Great Falls	6.4	1.5	58,150	4.5	31,499	3.6	29.8	7.0	401,714	30.9	244,918	28.4	46.4	11.0	311,427	24.0	112,078	13.0
3. Missoula	7.6	1.4	84,050	7.5	38,089	6.1	24.4	4.6	366,526	32.9	191,459	30.5	41.0	7.6	209,101	18.8	116,963	18.7
Small Urban 25,000–49,999																		
4. Butte	12.7	4.3	83,450	16.0	55,925	12.8	10.5	3.6	96,193	18.4	73,887	16.9	25.8	8.8	119,387	22.9	70,679	16.2
5. Helena	6.6	2.4	30,560	5.8	18,419	5.7	15.7	5.7	168,048	31.7	90,399	28.1	24.4	8.8	129,212	24.4	54,251	16.9
6. Bozeman	3.2	1.7	17,345	4.9	8,915	4.2	7.5	3.9	93,755	26.4	50,467	23.5	17.7	9.2	65,389	18.5	33,233	15.5
7. Kalispell	0	0	0	0	0	0	10.9	8.4	157,936	43.4	84,414	38.9	19.1	14.8	73,065	20.1	38,302	17.6
Small Urban 10,000–24,999																		
8. Havre	0	0	0	0	0	0	4.5	7.0	53,212	31.4	28,702	21.8	6.9	10.7	44,885	26.5	24,806	18.9
9. Miles City	0	0	0	0	0	0	6.0	8.3	43,364	35.8	24,294	24.1	6.1	8.4	19,856	16.4	11,096	11.0
10. Anaconda	0	0	0	0	0	0	7.3	19.7	66,357	48.4	39,044	35.2	3.2	8.6	12,904	9.4	6,435	5.8
Small Urban 5,000–9,999																		
11. Libby	0	0	0	0	0	0	9.0	16.2	68,022	53.8	42,472	47.3	4.6	8.3	6,234	4.9	3,997	4.5
12. Livingston	0.5	1.0	2,275	2.7	1,279	1.8	3.1	6.5	29,485	34.8	17,320	23.7	3.8	8.0	11,317	13.4	6,648	9.1
13. Lewistown	0	0	0	0	0	0	5.4	9.5	36,200	39.1	19,489	26.3	5.6	9.9	16,420	17.7	9,645	13.0
14. Glendive	1.0	2.3	3,640	3.3	1,968	2.4	5.1	11.6	53,379	48.6	29,113	35.2	3.3	7.5	17,202	15.7	10,105	12.2
15. Dillon	0	0	0	0	0	0	2.7	6.8	22,339	38.0	13,990	29.3	2.5	6.3	4,102	7.0	2,541	5.3
16. Laurel	0.7	1.9	4,410	6.2	2,856	5.0	0.7	1.9	5,383	7.5	3,162	5.5	5.9	15.8	30,296	42.2	17,797	31.0
17. Glasgow	0	0	0	0	0	0	3.3	7.7	24,847	38.7	14,487	27.7	5.1	11.9	10,944	17.0	6,182	11.8
18. Sidney	0	0	0	0	0	0	3.8	7.6	25,948	39.3	15,222	27.9	4.0	8.0	13,205	20.0	7,756	14.2
Totals	51.7	1.7	372,760	5.3	226,098	4.9	202.1	6.7	2,417,956	34.5	1,352,503	29.5	279.5	9.2	1,503,042	21.4	684,192	14.9

	COLLECTOR STREETS						LOCAL STREETS						TOTAL SYSTEM					
	1990				1972		1990				1972		1990				1972	
	Miles	%	DVM	%	DVM	%	Miles	%	DVM	%	DVM	%	Miles	%	DVM	%	DVM	%
Urbanized Areas																		
1. Billings	64.0	10.2	145,254	8.4	77,431	7.5	444.8	70.8	386,852	22.3	367,475	35.5	628.3	20.8	1,734330	24.7	1,033,416	22.5
2. Great Falls	36.2	8.6	148,694	11.5	82,651	9.6	303.4	71.9	378,314	29.1	392,249	45.4	422.2	13.9	1,298,299	18.5	863,395	18.8
3. Missoula	44.2	8.2	161,020	14.4	48,772	7.8	420.4	78.2	293,966	26.4	231,466	36.9	537.6	17.8	1,114,663	15.9	626,749	13.7
Small Urban 25,000–49,999																		
4. Butte	26.0	8.9	69,798	13.4	41,255	9.4	217.6	74.4	153,209	29.3	195,791	44.7	292.6	9.7	522,037	7.4	437,537	9.5
5. Helena	23.7	8.5	55,978	10.6	27,589	8.6	207.2	74.6	145,549	27.5	130,933	40.7	277.6	9.2	529,347	7.6	321,571	7.0
6. Bozeman	15.6	8.1	54,193	15.3	21,204	9.9	147.6	77.1	123,785	34.9	100,630	46.9	191.6	6.3	354,467	5.0	214,449	4.7
7. Kalispell	14.9	11.5	35,954	9.9	16,425	7.6	84.2	65.3	97,102	26.6	77,949	35.9	129.1	4.3	364,057	5.2	217,090	4.7
Small Urban 10,000–24,999																		
8. Havre	7.0	10.9	19,415	11.5	13,561	10.3	45.8	71.4	51,708	30.6	64,358	49.0	64.2	2.1	169,220	2.4	131,427	2.9
9. Miles City	7.2	9.9	15,820	13.0	11,375	11.3	53.2	73.4	42,133	34.8	53,983	53.6	72.5	2.4	121,173	1.7	100,748	2.2
10. Anaconda	3.9	10.5	15,820	11.5	11,363	10.3	22.7	61.2	42,133	30.7	53,927	48.7	37.1	1.2	137,214	2.0	110,769	2.4
Small Urban 5,000–9,999																		
11. Libby	6.2	11.2	14,331	11.3	7,540	8.4	35.7	64.3	37,918	30.0	35,784	39.8	55.5	1.8	126,505	1.8	89,793	2.0
12. Livingston	5.0	10.5	11,362	13.4	8,300	11.4	35.3	74.0	30,259	35.7	39,391	54.0	47.7	1.6	84,698	1.2	72,938	1.6
13. Lewistown	8.3	14.6	10,930	11.8	7,832	10.6	37.5	66.0	29,110	31.4	37,172	50.1	56.8	1.9	92,660	1.3	74,138	1.6
14. Glendive	4.7	10.7	9,707	8.8	7,236	8.7	29.8	67.9	25,853	23.6	34,343	41.5	43.9	1.5	109,781	1.6	82,765	1.8
15. Dillon	3.4	8.5	8,844	15.0	5,448	11.4	31.3	78.4	23,555	40.0	25,853	54.0	39.9	1.3	58,840	0.8	47,832	1.0
16. Laurel	6.4	17.2	8,629	12.0	5,845	10.2	23.5	63.2	22,982	32.1	27,740	48.3	37.2	1.2	71,700	1.0	57,400	1.3
17. Glasgow	3.2	7.4	7,766	12.1	5,518	10.5	31.3	73.0	20,684	32.2	26,188	50.0	42.9	1.4	64,241	0.9	52,375	1.1
18. Sidney	5.9	11.8	7,335	11.1	5,494	10.1	36.2	72.6	19,535	29.6	26,076	47.8	49.9	1.6	66,023	1.0	54.548	1.2
Totals	285.8	9.4	800,850	11.4	404,839	8.8	2,207.5	73.0	1,924.647	27.4	1,921,308	41.9	3,026.6	100.0	7,019,255	100.0	4,588,940	100.0

DVM = Daily Vehicle Miles of Travel

TABLE NO. 9

MILEAGE AND TRAVEL SUMMARY

Functional System	1990 Miles	1972 DVM	1972 Avg. ADT	1990 DVM	1990 Avg. ADT	% Increase in DVM 1972–1990
Rural						
Interstate ------	1,138.5	2,706,077	2,377	4,487,070	3,941	65.81%
Principal Arterials –	1,989.1	2,520,076	1,267	4,718,210	2,372	87.22%
Minor Arterials---	3,852.2	2,089,835	543	3,988,451	1,035	90.92%
Major Collectors --	5,810.5	1,017,992	175	1,849,762	318	81.70%
Minor Collectors--	10,464.3	546,236	52	907,255	87	66.09%
Local Roads ----	44,676.2	2,000,826	45	2,000,826	45	1.78%
Total Rural--	67,930.8	10,881,042	160	17,951,574	264	64.98%
Urban						
Interstate ------	51.7	226,098	4,373	372,760	7,210	64.87%
Principal Arterials –	202.1	1,352,503	6,686	2,417,956	11,952	78.78%
Minor Arterials---	279.5	684,192	2,451	1,503,042	5,383	119.68%
Collectors------	285.8	404,839	1,420	800,850	2,810	97.82%
Local Streets----	2,207.5	1,921,308	870	1,924,647	872	0.17%
Total Urban –	3,026.6	4,588,940	1,516	7,019,255	2,319	52.96%
Total State --------	70,957.4	15,469,982	218	24,970,829	352	61.41%

TABLE NO. 10

1990 RURAL DATA SUMMARY

Functional Classification	TOTAL						FAP		FAS		NFA	
	Miles	% of Total	Cum.% of Total	DVM (x1000)	% of Total	Cum.% of Total	Miles	DVM (x1000)	Miles	DVM (x1000)	Miles	DVM (x1000)
Principal Arterial System												
Interstate	1,138.5	1.7	1.7	4,487	25.0	25.0						
Other Principal Arterials	1,989.1	2.9	4.6	4,718	26.3	51.3	1,954.2	4,658	32.5	50	2.4	10
Minor Arterial System	3,852.2	5.7	10.3	3,988	22.2	73.5	2,682.7	2,963	1,103.6	813	65.9	212
Collector System												
Major Collectors	5,810.5	8.5	18.8	1,850	10.3	83.8	329.3	299	3,492.9	1,105	1,988.3	446
Minor Collectors	10,464.3	15.4	34.2	907	5.1	46.9	46.9	45	1,127.0	244	9,290.4	618
Local Road System	44,676.2	65.8	100.0	2,001	11.1	100.0	93.0	25	36.6	10	44,546.6	1,966
Rural Total	67,930.8	100.0	–	17,951	100.0	–	5,106.1	7,990	5,792.6	2,222	55,893.6	3,252

TABLE NO. 11

URBANIZED AREA DATA SUMMARY – BILLINGS

Functional Classification	TOTAL						FAP		FAS		NFA	
	Miles	% of Total	Cum.% of Total	DVM (x1000)	% of Total	Cum.% of Total	Miles	DVM (x1000)	Miles	DVM (x1000)	Miles	DVM (x1000)
Principal Arterial System												
Interstate ----------	13.0	2.1	2.1	89	5.1	5.1						
Other Principal Arterials --	52.4	8.3	10.4	705	40.6	45.7	36.6	567	11.4	111	4.4	27
Minor Arterial System ------	54.1	8.6	19.0	408	23.6	69.3	13.3	150	8.5	66	32.3	192
Collector System ---------	64.0	10.2	29.2	145	8.4	77.7	0	0	0	0	64.0	145
Local Street System -------	444.8	70.8	100.0	387	22.3	100.0	0	0	0	0	444.8	387
Urban Total ----------	628.3	100.0	–	1,734	100.0	–	49.9	717	19.9	177	545.5	751

TABLE NO. 12

URBANIZED AREA DATA SUMMARY – GREAT FALLS

Functional Classification	TOTAL						FAP		FAS		NFA	
	Miles	% of Total	Cum.% of Total	DVM (x1000)	% of Total	Cum.% of Total	Miles	DVM (x1000)	Miles	DVM (x1000)	Miles	DVM (x1000)
Principal Arterial System												
Interstate	6.4	1.5	1.5	58	4.5	4.5						
Other Principal Arterials	29.8	7.1	8.6	402	31.0	35.5	29.8	402	0	0	0	0
Minor Arterial System	46.4	11.0	19.6	311	24.0	59.5	23.7	194	6.1	38	16.6	79
Collector System	36.2	8.6	28.2	149	11.5	71.0	0	0	3.0	8	33.2	141
Local Street System	303.4	71.8	100.0	378	29.0	100.0	0	0	1.3	3	302.1	375
Urban Total	422.2	100.0	–	1,298	100.0	–	53.5	596	10.4	49	351.9	595

TABLE NO. 13

URBANIZED AREA DATA SUMMARY – MISSOULA

Functional Classification	TOTAL						FAP		FAS		NFA	
	Miles	% of Total	Cum.% of Total	DVM (x1000)	% of Total	Cum.% of Total	Miles	DVM (x1000)	Miles	DVM (x1000)	Miles	DVM (x1000)
Principal Arterial System												
Interstate	7.6	1.4	1.4	84	7.5	7.5						
Other Principal Arterials	24.4	4.5	5.9	366	32.8	40.3	16.8	267	7.6	99	0	0
Minor Arterial System	41.0	7.6	13.5	209	18.8	59.1	0.3	6	21.2	116	19.5	87
Collector System	44.2	8.2	21.7	161	14.5	93.6	0	0	3.9	51	40.3	110
Local Street System	420.4	78.3	100.0	294	26.4	100.0	0	0	0.3	1	420.1	293
Urban Total	537.6	100.0	–	1,114	100.0	–	17.1	273	33.0	267	479.9	490

TABLE NO. 14

URBAN AREA DATA SUMMARY – SMALL URBAN 5,000 - 50,000

Functional Classification	TOTAL						FAP		FAS		NFA	
	Miles	% of Total	Cum.% of Total	DVM (x1000)	% of Total	Cum.% of Total	Miles	DVM (x1000)	Miles	DVM (x1000)	Miles	DVM (x1000)
Principal Arterial System												
Interstate	24.7	1.7	1.7	142	4.9	4.9						
Other Principal Arterials	95.5	6.6	8.3	944	32.9	37.8	84.7	900	6.5	25	4.3	19
Minor Arterial System	138.0	9.6	17.9	574	20.0	57.8	18.9	129	34.7	154	84.4	291
Collector System	141.4	9.8	27.7	346	12.1	69.9	3.1	7	4.0	15	134.3	324
Local Street System	1,038.9	72.3	100.0	865	30.1	100.0	1.3	1	0.7	1	1,036.9	863
Urban Total	1,438.5	100.0	–	2,871	100.0	–	108.0	1,037	45.9	195	1,259.9	1,497

PART III

NEEDS ANALYSIS

PART III – NEEDS ANALYSIS

A. DESCRIPTION OF NEEDS ANALYSIS PROCEDURE

Needs to construct the functionally classified highway system to an adequate standard are estimated by following a logic process procedure. The logic process used in identifying deficient sections is as follows:

(1) Identify and describe study sections.

(2) Set up criteria for measuring the adequacy of a facility (defined as minimum tolerable conditions).

(3) Compare the existing conditions with the minimum tolerable conditions.

(4) Identify the deficient sections and the type of deficiency.

Required improvements (i.e., new location, reconstruction, resurfacing, widening, etc.) are based upon the type of deficiency and the proposed standard of the improved road. Cost estimates for the required improvement were made by using construction costs data obtained from the Department of Highways.

To facilitate the needs analysis procedure, each route was divided into logical study sections. For the routes on federal-aid primary, the study sections corresponded to the sections shown in the Department of Highways *Sufficiency Rating* publication. For routes not on the primary system, the sections were divided into lengths that would correspond to a logical construction section. A worksheet was prepared for each study section, deficiency analysis conducted, improvement type determined, and estimated costs to construct the improvement applied.

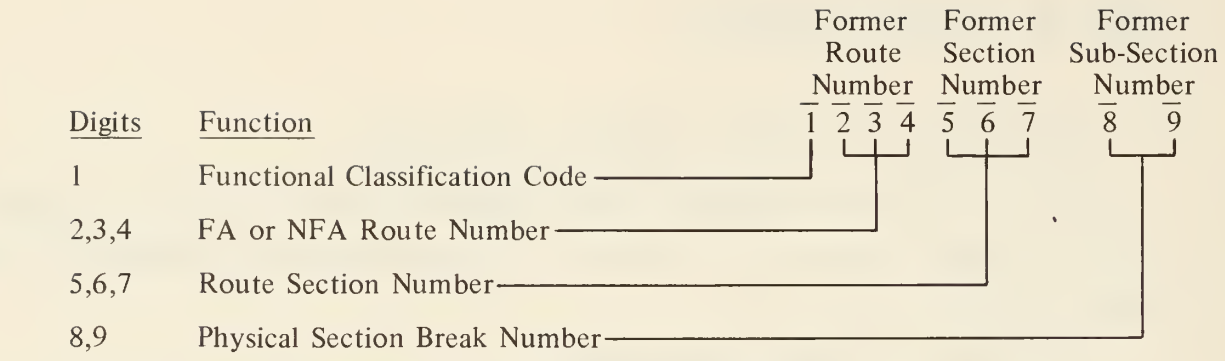
B. ROUTE NUMBERING SYSTEM

(1) General

In order to provide a more precise system of identifying each section of road in the state, the decision was made to develop a new numbering system for urban and rural highways. The new system provides a unique number for each section and identifies its functional classification, federal-aid classification, and to some extent, its location. A total of nine digits are used corresponding to the route, section, and sub-section digits on the urban and rural worksheets.

(2) Rural Route Numbering System

Rural highways are identified in the following manner:



Digits	Function
1	Functional Classification Code
2,3,4	FA or NFA Route Number
5,6,7	Route Section Number
8,9	Physical Section Break Number

Rural functional classification code numbers are as follows:

Interstate ———————— 1

Principal Arterial ———————— 2

Minor Arterial ———————— 3

Major Collector ———————— 8

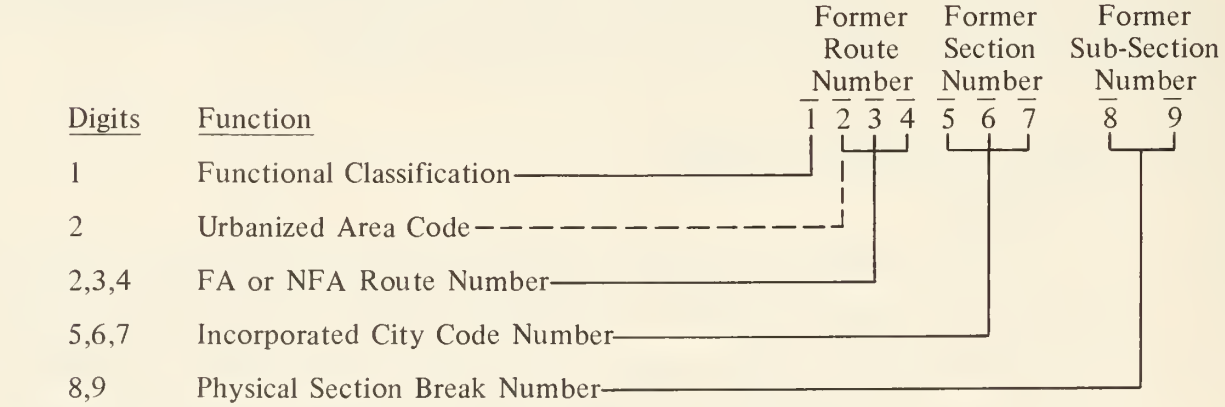
Minor Collector ———————— 9

Local Road———————— 6

Route sections (digits 5, 6, and 7) are numbered consecutively from the beginning of the route with breaks made at junctions with county lines and urban-in-fact boundaries. Thus, a typical route number on a section of FAP-1 classified as a principal arterial would be 2001-006-01.

(3) **Urban Route Numbering System**

The numbering of urban highways differs somewhat from the rural as follows:



Digits	Function
1	Functional Classification
2	Urbanized Area Code
2,3,4	FA or NFA Route Number
5,6,7	Incorporated City Code Number
8,9	Physical Section Break Number

Urban functional classification code numbers are as follows:

Interstate ———————— 1

Principal Arterials ———————— 5

Minor Arterials ———————— 7

Collectors ———————— 9

Local Roads ———————— 6

The urbanized area code identifies the urbanized area on previously renumbered federal-aid highways in Billings and Great Falls.

The route section number of the rural numbering system has been replaced with a 3-digit code number identifying the incorporated city. The sub-section numbers, as in the rural system, identify the physical section breaks and are numbered consecutively from the beginning of the urban route to the end.

(4) Non-Federal-Aid Route Numbering

Both urban and rural NFA routes were assigned 3-digit route numbers. The rural NFA routes were numbered consecutively from No. 801 beginning in Beaverhead County and continuing alphabetically through Yellowstone County. Urban NFA routes were numbered consecutively beginning with No. 701 in each urban-in-fact area.

(5) Spur Routes

Rural spur routes of federal-aid systems are identified by the prefix 9 on the 3-digit route section number. Urban spurs are identified by the prefix 5 on the 2-digit sub-section number. For example, a spur route of FAP-1 might be identified as follows: 2001-901-01. Likewise, an urban spur of FAP-2 in Butte might be 5002-018-51.

C. DESCRIBING EXISTING CONDITIONS

Describing the existing physical condition of the roadway sections that were analyzed was done in two ways: (1) on federal-aid primary roads, the detailed data in the Federal-Aid Road Log and the Montana Primary Highways Sufficiency Rating was used; and (2) on federal-aid secondary and non-federal-aid roads, a field inventory was done to collect sufficient data to describe the section in detail.

In the case of rural minor collectors and local roads, and urban collectors and local streets, no new information was collected. These systems will not be on the future federal-aid system (with the exception of some urban collectors on the federal-aid urban system), and it was felt that the effort required to inventory these roads was not warranted. Data collected for the 1970-1990 Study was used as a representative sample to project needs on these systems.

The data coded to describe the physical conditions of each section of roadway is shown under *Existing Conditions (1972)* of the arterial and collector worksheets on Figures No. 5 and 6.

D. FIELD INVENTORY

A field inventory was conducted on the rural principal arterials, minor arterials, and major collectors and the urban principal arterials and minor arterials, excluding those routes on the federal-aid primary system.

FIGURE NO. 5
RURAL ARTERIAL AND COLLECTOR WORKSHEET

BOB No. 04 S69053

CARD 1

IDENTIFICATION

		Columns
1.	State	1-2
2.	County _____	3-5
3.	Route Number	6-9
4.	Route Section	10-12
5.	Subsection Number	13-14
6.	Length (0.1 mile)	15-17
7.	1968 Functional Classification	18
8.	1990 Functional Classification	19

Code ('68 and '90)	Functional System
1	Interstate
2	Other Principal Arterial
3	Minor Arterial
4	Major Collector
5	Minor Collector
6	Local ('68 Only)
7	Did Not Exist ('68 Only)

9.	Federal-aid System 1 FAP, Including Interstate, 2 FAS, 3 Non FA, 4 New		20
10.	Jurisdictional Responsibility 1 State, 2 Federal Domain, 3 Toll, 4 Other Existing, 5 New		21

EXISTING CONDITIONS

Geometrics

11.	Access Control (Full 1 | Partial 2 | None 3)		22
12.	Lane Width (feet)_____		23-24
13.	Number of Lanes		25-26
14.	Shoulder Width (feet) _____ Right _____ Left		27-28 29-30
15.	Terrain (Flat 1 | Rolling 2 | Mountainous 3)		31
16.	Percent of Length with Intolerable Safe Speed		32-33
17.	Percent of Length with Sight Distance ≥ 1500 feet		34-36
18.	Median Width (feet)		37-38
19.	Average Highway Speed (mph)		39-40
20.	Number of Signals and/or Stop Signs		41-42
21.	Type of Development (Rural 1 | Dense 2)		43
22.	Available Right-of-Way _____ feet		

Traffic

23.	ADT		44-49
24.	Percent Trucks		50-51
25.	K Factor (DHV/ADT)		52-53
26.	Directional Factor		54-55
27.	Capacity (hourly)		56-60
28.	Operating Speed (mph)		61-62

Structural

29.	Surface Type		63

1	High-Flexible
2	High-Rigid
3	Intermediate
4	Low
5	Gravel
6	Graded & Drained

30.	Pavement Section		64

('SN' Known 1 \| 'D' Known 2 \| Heavy 3 \| Medium 4 \| Light 5)

	Structural Number (SN) or Slab Thickness (D)		65-66
31.	Pavement Condition (PSR or equivalent- 0.0)		67-68
32.	Shoulder Type (Surfaced 1 | Stabilized 2 | Earth 3)		69
33.	Drainage Adequacy (Good 1 | Fair 2 | Poor 3)		70
	CARD NUMBER	1	80

REMARKS: _____

CARD 2

ANALYSIS OF DEFICIENCIES

			Columns
1-5	Identification (Repeat card 1)		1-14
34.	1990 ADT		20
35.	Average Annual Traffic Growth_____ %		
36.	Percent of Length with Intolerable Safe Speed (1990)		21-22
37.	Time of Pavement Condition Deficiency (Now 1 | 1-5 2 | 6-10 3 | 11-15 4 | 16-20 5 | 20- 6)		24
38.	Deficiencies:		

Code		Now	1-5	6-10	11-15	16-20	20-
	Operating Speed	1					
	Lane or Roadway Width	2					
	Safe Speed	3					
	Pavement Type and/or Condition	4					
	Shoulders	5					
	None	6					

39.	Initial Deficiency Code		25
40.	Secondary Deficiency Code		26
41.	Period Section Becomes Deficient (Now 1 | 1-5 2 | 6-10 3 | 11-15 4 | 16-20 5 | 20- 6)		27

DESCRIPTION OF IMPROVEMENT

42.	Year of Improvement		28-29
43.	ADT First Year After Improvement		30-35
44.	Type of Improvement		36

0	No Improvement
1	New Location
2	Reconstruction
3	Isolated Reconstruction
4	Major Widening
5	Minor Widening
6	Resurfacing and Shoulder Improvement
7	Resurfacing

45.	Design Year ADT		37-42
46.	Design Standard Number		43-44
47.	Access Control (Full 1 | Partial 2 | None 3)		45
48.	Number of Lanes		46-47

RAILROAD CROSSINGS

Number of RR Crossing With:

		Present	1990	
49.	No Protective Devices			48
50.	Cross Bucks			49-50
51.	Flashing Lights			51-52
52.	Flashing Lights and Gates			53-54
53.	Grade Separations			55-56

STRUCTURES

54.	Number of Structures (Present)		57-58

Number of Deficiencies (Existing Structures):

55.	Width		59-60
56.	Vertical Clearance		61-62
57.	Loading		63-64
58.	Other		65-66
59.	Number of New Structures Needed		67-68
60.	Time of Structure Needs (Now 1 | 1-5 2 | 6-10 3 | 11-15 4 | 16-20 5 | 20- 6)		69
	CARD NUMBER	2	80

CARD 3

COSTS, Thousands

1-5	Identification (Repeat card 1)		1-14
61.	Right-of-Way		15-20
62.	Grading & Drainage		21-26
63.	Surface & Base		27-30
64.	Other		31-34
65.	Structures (incl. RR Grade Sep.)		35-40
66.	Maintenance		41-44
67.	Administration		45-48
68.	Total		49-54
69.	Cost Area		55-56
70.	Expansion Factor (00.00)		57-60
	CARD NUMBER	3	80

REMARKS: _____

FIGURE NO. 6

URBAN ARTERIAL AND COLLECTOR WORKSHEET

BDB No 04 569053

CARD 4 — IDENTIFICATION

		Columns
1.	State	1-2
2.	Urbanized or Small Urban Area	3-5
3.	County	6-8
4.	Route Number	9-12
5.	Route Section	13-15
6.	Subsection Number	16-17
7.	Length (0.1 mile)	18-20
8.	1968 Functional Classification	21-22
9.	1990 Functional Classification	23-24

Code	Population	Code	Population
997	5,000- 9,999	999	25,000-49,999
998	10,000-24,999	*	50,000+

*Use Urbanized Area Code (See Appendix A)

Urban Code ('68 and '90) Pop	5-10	10-25	25-50	50-	Functional System	Rural Code ('68)
11	21	31	41		Interstate	01
12	22	32	42		Other Freeway & Expressway	–
13	23	33	43		Other Principal Arterial	02
14	24	34	44		Minor Arterial	03
15	25	35	45		Collector	–
–	–	–	–		Major	04
–	–	–	–		Minor	05
16	26	36	46		Local ('69 only)	06
AA	BB	CC	DD		Did Not Exist ('68 only)	EE

10.	Federal-aid System: 1 FAP, Including Interstate, 2 FAS, 3 Non-FA 4 New	25	
11.	Jurisdictional Responsibility: 1 State, 2 Federal Domain, 3 Toll, 4 Other Existing, 5 New	26	
12.	Connecting Link of: 1 Rural Principal Arterial, 2 Rural Minor Art'l, 3 Not a Connecting Link	27	

EXISTING CONDITIONS

GEOMETRICS

13.	Access Control (Full 1 | Partial 2 | None 3)	28	
14.	Approach (curb-curb) or Lane Width (feet)	29-31	
15.	Number of Lanes	32-33	
16.	Shoulder Width (where applicable; feet) Right / Left	34-35 / 36-37	
17.	Peak Hour Parking (One Side 1 | Both Sides 2 | None 3)	38	
18.	Peak Hour Operation (1-Way 1 | 2-Way 2 | 1-Way Rev 3 | 2-Way Rev 4)	39	
19.	Percent of Length with Intolerable Safe Speed (where applicable)	40-41	
20.	Median Width (feet)	42-43	
21.	Median Type (Curbed 1 | Positive Barrier 2 | Unprotected 3)	44	
22.	Average Highway Speed (Fwys & Expys Only)	45-46	
23.	Number of Signalized Intersections	47-48	
24.	Typical Percent Green Time	49-50	
25.	Type of Signalization (1 Uncoordinated Fixed Time 2 Traffic Actuated 3 Progressive)	51	
26.	Estimated Total Available Row Width (feet)		
27.	Prevailing Type of Area	52	

1 CBD-3 Stories or Less
2 CBD-4 Stories or More
3 Fringe
4 Outlying Business District
5 Residential – Apartments and Row Houses
6 Residential – Single Family – 1/2 Acre or Less
7 Residential – Single Family – Over 1/2 Acre
8 Rural

TRAFFIC

28.	ADT	53-58	
29.	Percent Trucks	59-60	
30.	K Factor (DHV/ADT)	61-62	
31.	Directional Factor	63-64	
32.	Capacity (Hourly)	65-69	
33.	Present Operating Speed (Fwys & Expys Only)	70-71	

STRUCTURAL

34.	Surface Type	72	
35.	Pavement Section ('SN' Known 1 | 'D' Known 2 | Heavy 3 | Medium 4 | Light 5) Structural Number (SN) or Slab Thickness (D)	73 / 74-75	
36.	Pavement Condition (PSR or equivalent-0.0)	76-77	
37.	Shoulder Type (Surfaced 1 | Stabilized 2 | Earth 3)	78	
38.	Drainage and Cross Section Adequacy (Good 1 | Fair 2 | Poor 3)	79	

1 High-Flexible
2 High-Rigid
3 Intermediate
4 Low
5 Gravel
6 Graded & Drained

CARD NUMBER 4 — 80

CARD 5 — ANALYSIS OF DEFICIENCIES

		Columns
1-6	Identification (Repeat card 4)	1-17
39.	1990 ADT	18-23
40.	Average Annual Traffic Growth %	
41.	Time of Pavement Condition Deficiency (Now 1 | 1-5 2 | 6-10 3 | 11-15 4 | 16-20 5 | 20 6)	25
42.	Deficiencies:	

Code	Now	1-5	6-10	11-15	16-20	20
Operating Speed or V/C Ratio 1						
Lane Width 2						
Safe Speed 3						
Pavement Type and/or Condition 4						
Cross Section & Drainage 5						
None 6						

43.	Initial Deficiency Code	26	
44.	Secondary Deficiency Code	27	
45.	Period Section Becomes Deficient (Now 1 | 1-5 2 | 6-10 3 | 11-15 4 | 16-20 5 | 20 6)	28	

DESCRIPTION OF IMPROVEMENT

46.	Year of Improvement	29-30	
47.	ADT First Year After Improvement	31-36	
48.	Type of Improvement	37	
49.	Design Year ADT	38-43	
50.	Design Standard Number	44-45	
51.	Access Control (Full 1 | Partial 2 | None 3)	46	
52.	Number of Lanes	47-48	
53.	Traveled Way Width (feet)	49-51	

0 No Improvement
1 New Location
2 Reconstruction
3 Isolated Reconstruction
4 Major Widening (Freeways & Expressways)
5 Minor Widening (Freeways & Expressways)
6 Widening–Other Arterials & Collectors
7 Resurfacing & Shoulder Improvements
8 Resurfacing

RAILROAD CROSSINGS

	Number of RR Crossings with:	Present	1990	
54	No Protective Devices			52
55	Cross Bucks			53-54
56.	Flashing Lights			55-56
57.	Flashing Lights and Gates			57-58
58.	Grade Separation			59-60

STRUCTURES

59.	Number of Structures (Present)	61-62
	Number of Deficiencies (Existing Structures):	
60.	Width	63-64
61.	Vertical Clearance	65-66
62.	Loading	67-68
63.	Other	69-70
64.	Number of New Structures Needed	71-72
65.	Time of Structure Needs (Now 1 | 1-5 2 | 6-10 3 | 11-15 4 | 16-20 5 | 20 6)	73

CARD NUMBER 5 — 80

CARD 6 — COST, Thousands

		Columns
1-6	Identification (Repeat card 4)	1-17
66.	Right-of-Way	18-23
67.	Grading & Drainage	24-29
68.	Surface & Base	30-33
69.	Other	34-37
70.	Structures (incl. RR Grade Sep.)	38-43
71.	Maintenance	44-47
72.	Administration	48-51
73.	Total	52-57
74.	Expansion Factor (00.00)	58-61

CARD NUMBER 6 — 80

Remarks: _____

The field inventory consisted of driving the roads and coding information which described the physical type and condition of the road. Data recorded included length of section, cross-section characteristics, pavement type and condition, traffic control devices, safe speed and sight distance restrictions, and type of development near the roadway. This data, particularly the section lengths, was checked with existing recorded data where possible.

Approximately 5,933 miles of roadway was field inventoried during this study.

Problems encountered in field inventory were:

(1) On federal-aid secondary routes, some study sections did not agree with data recorded in the Federal-Aid Road Log with regard to length, width and pavement type. On non-federal-aid routes, field data did not always agree with the Department of Highways' local road inventory. Adjustments were made to make the field inventory agree with the official state data. However, those sections not agreeing were documented and referred to the Department of Highways for possible future correction.

(2) In rural areas, some difficulty was encountered in determining the percent of length with intolerable safe speed and percent of length with sight distance less than or equal to 1,500 feet. The method used was to record the intolerable length as measured by the automobile odometer and divide the intolerable length by the section length to obtain the percent intolerable.

(3) Safe speeds were estimated by driving the section at a prudent speed.

(4) In urban areas, heavy traffic volumes made it difficult to measure roadway widths. Also, the percent of green time at peak hour periods was difficult to obtain because of the short peak hour periods.

Overall, however, it is felt that the data collected during the field inventory is sufficiently accurate for the purposes of this study.

E. MINIMUM TOLERABLE CONDITIONS

Minimum tolerable conditions establish the criteria by which the physical description of each section of roadway is compared to determine the adequacy or deficiency of each section. If the existing condition of the roadway did not meet or exceed the minimum tolerable conditions, the section was considered to be inadequate (backlog deficiency). If the section was adequate now, the condition of the roadway was projected in five-year increments to determine if the section would become deficient in the period from 1972 to 1990 (accruing deficiency).

Minimum tolerable conditions provided by the Federal Highway Administration for the 1970-1990 Study were reviewed by the Consultant. Some recommendations for changes were made to bring the minimum tolerable conditions into agreement with current state practices. The revised

minimum tolerable conditions were submitted to a review by the Department of Highways and Federal Highway Administration. Comments from these agencies were incorporated into the Minimum Tolerable Condition Tables.

The minimum tolerable conditions that were used to determine deficiencies for the 1974 Update are shown in Tables No. 15 and 16.

F. DESIGN STANDARDS

The type and costs of improvements to be made on deficient sections is dependent upon the design standard of the proposed facility.

Design standards provided by the Federal Highway Administration for the 1970-1990 Study were reviewed by the Consultant and modified to agree with current state practices. The revised design standards were reviewed by a committee within the Department of Highways and by the Federal Highway Administration. Comments from these groups were incorporated into the design standard tables.

The final design standard tables are shown in Appendix A.

As part of the process of quantifying design standards, the Consultant prepared typical sections of the design standards to be used in determining quantities. These typical sections are shown in Appendix A.

G. TRAFFIC AND CAPACITY

Traffic data was compiled and coded on worksheets by the Planning and Research Bureau – Department of Highways. Existing traffic data was available on most urban and rural highways from normal traffic counts taken each year by the Department of Highways. Since the Department of Highways anticipated the need for this study, many local road and street counts were taken in addition to normal traffic counts. Existing traffic data, based upon these actual field counts, is considered to be accurate and representative of actual traffic.

Traffic was projected by examining historical records on traffic volumes and projecting the trends into the future. In those cases where transportation plans had been completed and traffic assignments made on a future network, those projected traffic volumes were used. It is noted that historical trends and transportation plans done in the past may not have relevance in the future. However, it is beyond the scope of this study to assess the future effect of the energy crisis because of inadequate data in the present and uncertainties in the future. We have therefore determined that for the purposes of this study, historical data is the best information that can be used.

Operating speeds for each functional system was specified in the minimum tolerable conditions and design standard tables. These operating speeds established the level of service for each system

depending on the type of travel each system was to serve. Capacity calculations and existing traffic volumes were used with the operating speed curves in the *Highway Capacity Manual* and the physical limitations of the roadway to determine the number of lanes, parking restrictions, and other operating characteristics of the roadway.

H. DEFICIENCY AND IMPROVEMENT ANALYSIS

(1) General

Deficiencies in a roadway section occur when the physical characteristics of the roadway do not meet or exceed the established minimum tolerable conditions. (Minimum tolerable conditions are shown in Tables No. 15 and 16.) If the section is adequate now, the physical characteristics are projected to see if the section would become deficient sometime in the study period.

The type of improvement to be applied to a deficient section is based upon the type of deficiencies occurring. Improvement types used in this study were new location, reconstruction, isolated reconstruction, widening, or resurfacing. The improvement type was chosen by a combination of logic charts (illustrated in Figures No. 7 through 10), knowledge of the particular roadway section, and judgement.

(2) Deficiency Analysis

The deficiency analysis was conducted for the period 1974 through 1995. Any deficiency occurring during or before 1974 was considered to be a backlog deficiency. A deficiency occurring after 1974 and before 1995 was considered an accruing deficiency. Accruing deficiencies were determined and reported in five-year increments on the worksheets.

Deficiencies for both urban and rural roads were grouped into five general categories as follows:

(a) Operating Speed Deficiency

An operating speed deficiency occurs when the operating speed falls below the operating speed specified in the minimum tolerable condition tables. Operating speeds were determined by calculating the traffic-volume-to-capacity (v/c) ratio and, combined with the average highway speed, using the operating speed curves in the *Highway Capacity Manual* to determine the operating speed.

(b) Lane or Roadway Width Deficiency

A lane or roadway width deficiency occurred when the lane width was less than eleven feet for rural sections or less than ten feet for urban sections. The lane width combined with the shoulder type and width as specified in the minimum tolerable conditions tables determined the roadway width adequate or deficiency.

TABLE NO. 15

MINIMUM TOLERABLE CONDITIONS FOR RURAL ARTERIALS AND COLLECTORS

Functional System	PRIN. ART.			MINOR ARTERIALS									COLLECTORS								
Analysis Year A.D.T.	All			0 - 450			450 - 2800			2800+			0 - 100			100 - 450			450 - 2800			2800+		
Terrain	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M
Operating Speed (Peak Hr.)	55	50	45	40	40	35	50	45	40	50	45	40	–	–	–	–	–	–	40	35	30	40	35	30
Surface Type (Note 1)	High			Intermediate			Intermediate			High			Gravel			Low			Intermediate			Intermediate		
Surfaced Roadway Width	32	32	30	28	28	26	28	28	26	30	30	28	22			24	24	24	28	26	26	30	28	28
Lane Width	11			11			11			11			11			11			11			11		
Paved Shoulder Width	5	5	4	3	3	2	3	3	2	4	4	3	–	–	–	1	1	1	3	2	2	4	3	3
Safe Speed	65	55	45	60	50	40	60	50	40	60	50	40	40	35	25	50	40	30	50	40	30	50	40	30
Stopping Sight Distance	550	415	315	475	350	275	475	350	275	475	350	275	–	–	–	350	275	200	350	275	200	350	275	200
Maximum Curvature (Degrees)	5	6	10	5	8	13	5	8	13	5	8	13	–	–	–	8	13	23	8	13	23	8	10	18
Maximum Gradient, % (Note 2)	3	4	8	3	5	9	3	5	9	3	5	9	–	–	–	4	6	11	4	6	11	4	5.5	10
Number of Lanes	Note 3			2	2	2	2	2	2	Note 3			2	2	2	2	2	2	2	2	2	Note 3		
Pavement Condition Rating (Note 4)	2.6			2.1			2.1			2.6			–			2.1			2.1			2.1		
RR Crossing Protection (Note 5)																								
Structures:																								
Width (Note 6)	T + 6′			T + 4′			T + 4′			T + 4′			–			T + 2′			T + 2′			T + 2′		
Vertical Clearance	15			14			14			15			14			14			14			15		
Loading	H - 20			H - 15			H - 15			H - 20			H - 15			H - 15			H - 15			H - 20		

Notes

1. Surface Type: *High*–Mixed bituminous or bituminous penetration road on a rigit base or on a flexible base with a combined (surface and base) thickness of 7 inches or more. Also, any portland cement concrete; *Intermediate*–Mixed bituminous or bituminous penetration road on a flexible base with a combined thickness of less than 7 inches; *Low*–Bituminous surface course (less than 1 inch thick) on a base suitable to carry occasional heavy axle loads.
2. Short grades less than 500 feet in length may be two percent steeper.
3. Number of lanes required to maintain the peak hour operating speed specified above.
4. Defined by: Present Serviceability Rating (PSR), Present Serviceability Index (PSI), or Equivalent Sufficiency Rating.
5. As defined in Table III-15, pg. III-39, *Railroad Crossing Protection Criteria*, National Highway Functional Classification and Needs Study Manual, Federal Highway Administration, February 1970. (BOB No. 04 - S69053).
6. T = Traveled Way; for bridges over 250′ long, widths 4′ less than shown, but never less than the approach traveled way, will be considered tolerable.
7. The minimum tolerable conditions shown above are intended only as the basis for determining the adequacy, or inadequacy, of the study sections in the highway needs analysis. They are not intended to certify the adequacy of any particular section of highway.

TABLE NO. 16

MINIMUM TOLERABLE CONDITIONS FOR URBAN ARTERIALS AND COLLECTORS

Functional System	Freeway/expressway (Uninterrupted flow)		Other Urban Principal Arterial	Urban Minor Arterial	Urban Collector Street	
Type of Area	Built-up Area	Outlying Area				
Operating speed (peak hr.)--	35	40	–	–	Surface width ------	Sufficient traffic lanes to restrict congestion (v/c >0.9) to a relatively short daily period. A capacity analysis is not warranted unless ADT exceeds 7,000.
V/C ratio (peak hr.)------	–	–	0.85	0.90		
Lane width (ft.) --------	11	11	10	10		
No. of lanes ----------	(1)	(1)	(2)	(2)	Lane width (ft.) -----	10
Surface type ----------	High		High	Intermediate	Cross section -------	On uncurbed sections at least a 5-ft. shoulder should exist with a ditch adequate to carry all but extremely heavy rainfall. Where adjacent area is more than 50% developed, a curbed section should exist.
Graded right shldr. width (ft.)	8	8	6′ on uncurbed sections			
Shoulder type ---------	Surfaced		Stabilized			
Median protection ------	(3)	(3)	–	–		
Cross section (4) -------	–	–	Curbs, gutters, and enclosed drainage		Safe speed (mph) (7) --	25
Safe speed (5) ---------	–	–	35	30	Surface type -------	Low
Pavement condition rating --	2.6	2.6	2.6	2.1	Pavement condition (PSR or equivalent) –	2.1
RR crossing protection ----	See Table A-3				RR crossing protection –	See Table A-3
Structures:					Structures:	
Width (ft.) ---------	Traveled-way width + 6 feet		Curb-curb width of approach roadway (6)		Width (ft.)-------	Prevailing width of travel way
Vertical clearance (ft.)---	14	14	14	14	Vertical clearance (ft.)	14
Loading ----------	H-20	H-20	H-15	H-15	Loading --------	H-15

(1) As necessary to maintain minimum operating speed specified.

(2) Overall street width as required to maintain maximum v/c ratio.

(3) Positive type median protection unless width is at least 30 feet.

(4) An open ditch section on arterial streets in outlying areas with less than 50% development is tolerable.

(5) This item is applicable to at-grade streets in outlying sections of urban areas where travel speeds are such that alignment becomes an important consideration. The lengths of critical curves and/or sight distance situations will be evaluated in determining needs.

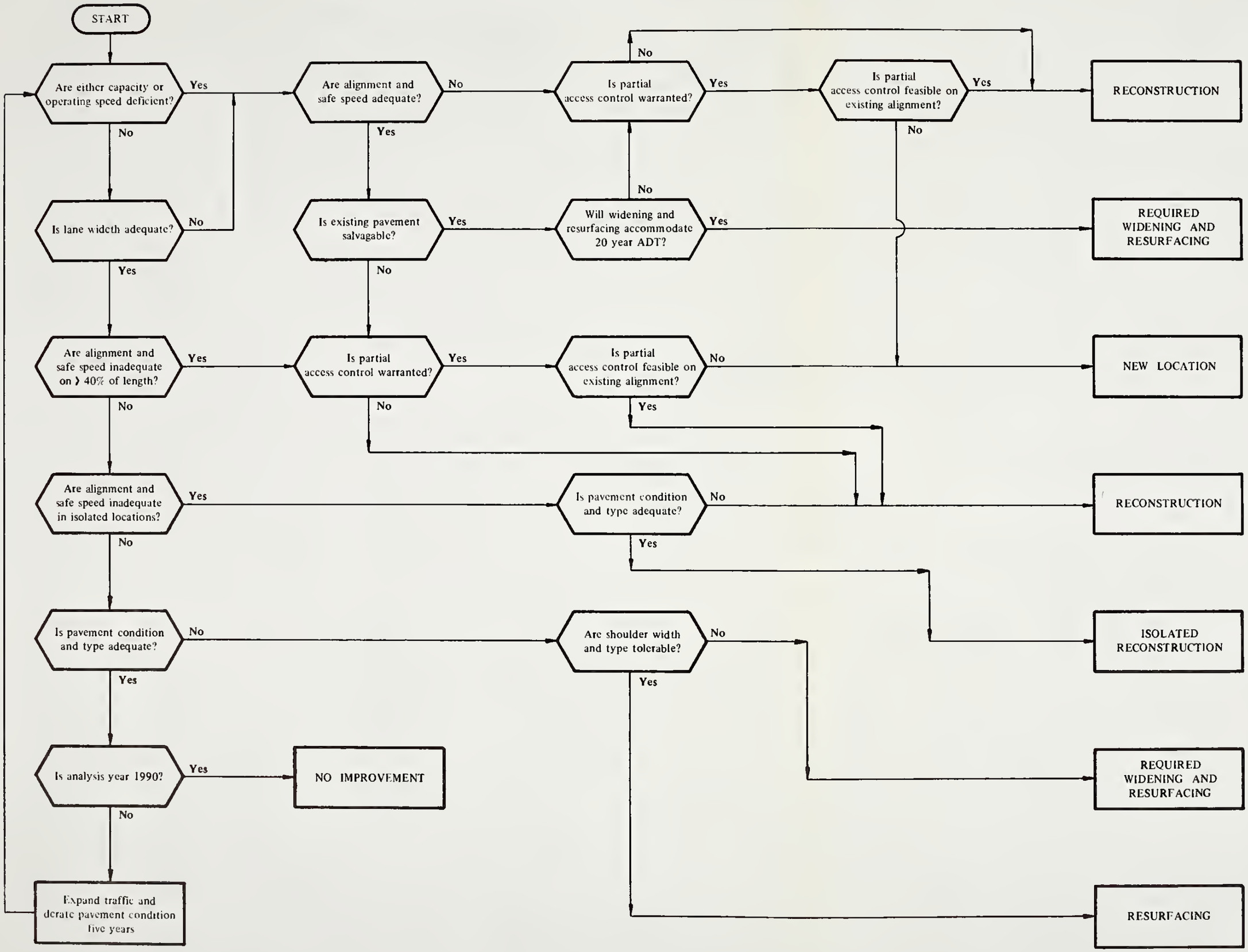
(6) Where a shoulder rather than curbed section is tolerable, the structure width should be at least the traveled way width plus four feet.

(7) This item is applicable to collector streets in outlying sections of urban areas where travel speeds are such that alignment becomes an important consideration. The number of critical curves or sight distance situations will be evaluated in determining needs.

(8) The minimum tolerable conditions shown above are intended only as the basis for determining the adequacy, or inadequacy, of the study sections in the highway needs analysis. They are not intended to certify the adequacy of any particular section of highway.

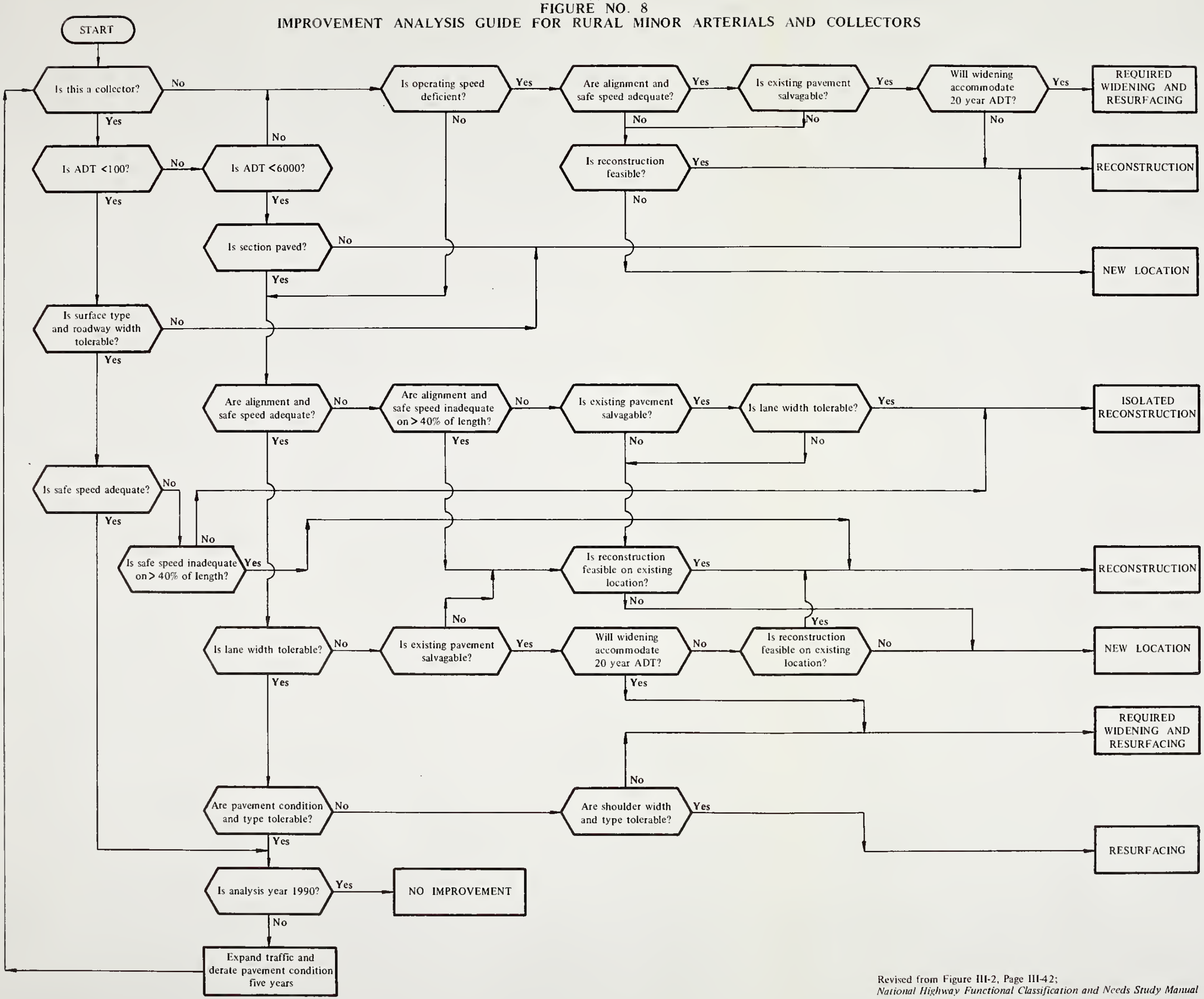
FIGURE NO. 7

IMPROVEMENT ANALYSIS GUIDE FOR RURAL PRINCIPAL ARTERIALS



Revised from Figure III-1, Page III-41;
National Highway Functional Classification and Needs Study Manual

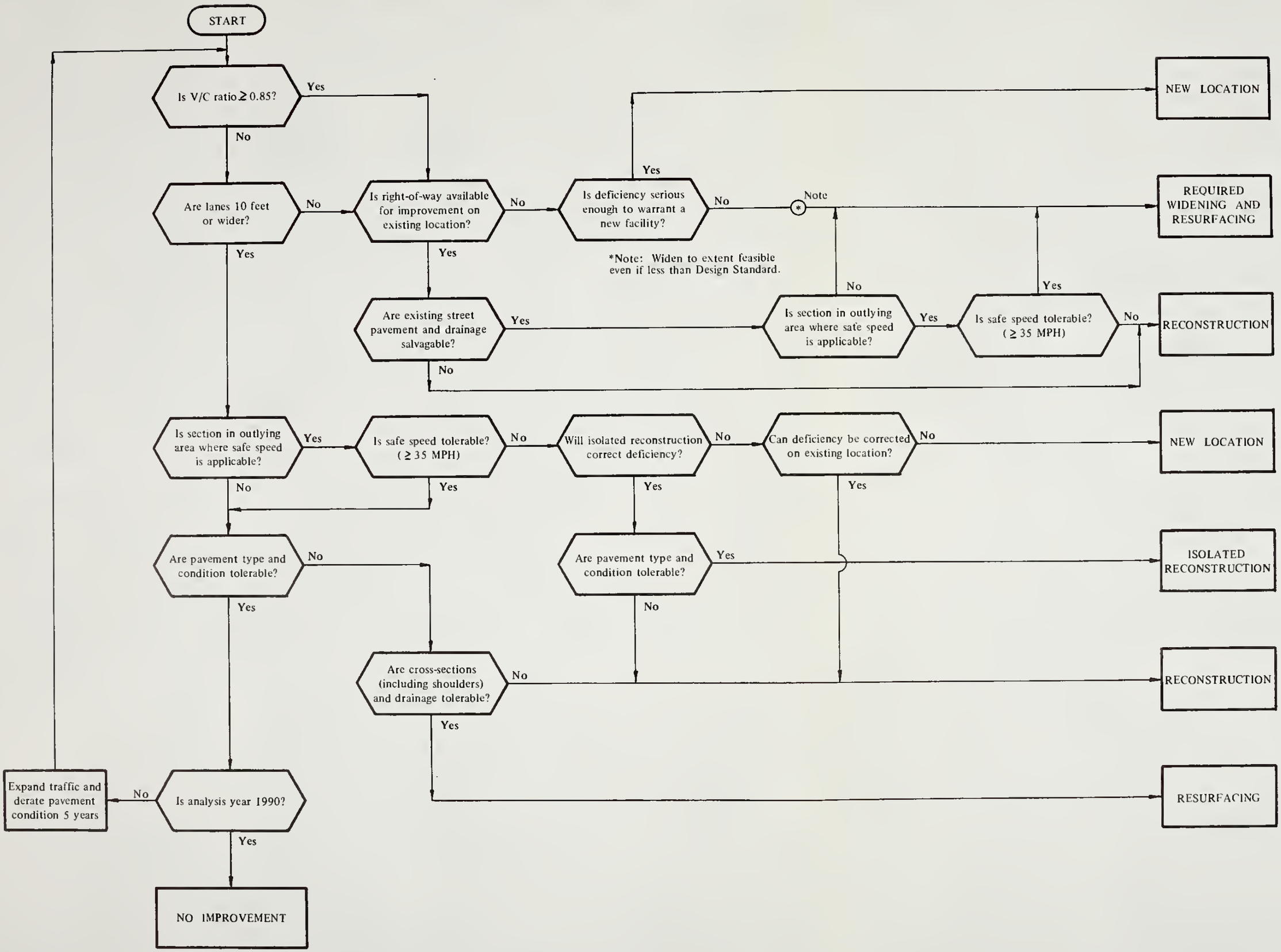
FIGURE NO. 8
IMPROVEMENT ANALYSIS GUIDE FOR RURAL MINOR ARTERIALS AND COLLECTORS



Revised from Figure III-2, Page III-42;
National Highway Functional Classification and Needs Study Manual

FIGURE NO. 9

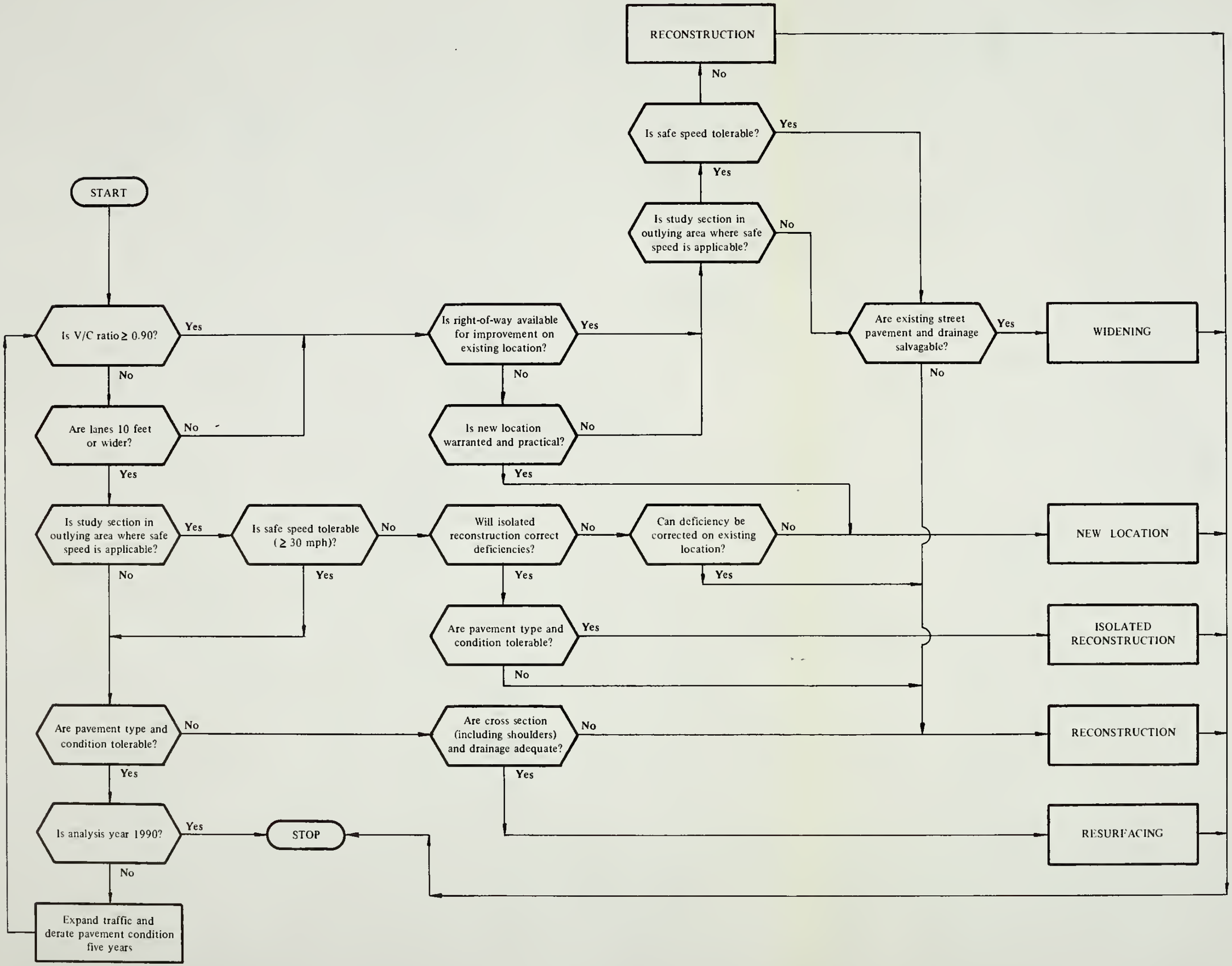
IMPROVEMENT ANALYSIS GUIDE FOR URBAN PRINCIPAL ARTERIALS



Revised from Figure III-3, Page III-43;
National Highway Functional Classification and Needs Study Manual

FIGURE NO. 10

IMPROVEMENT ANALYSIS GUIDE FOR URBAN MINOR ARTERIALS



(c) Safe Speed Deficiency

A safe speed deficiency occurred when the physical characteristics on a portion of the roadway would lower the safe driving speed below the minimum tolerable conditions. Sections having 40% or greater lengths with intolerable safe speed were considered to be totally deficient and required reconstruction. Sections with 20 to 40% of their lengths with intolerable safe speed (if no other deficiency occurred) were considered for isolated reconstruction.

(d) Pavement Deficiency

A pavement type or condition deficiency occurred when the pavement failed to meet the minimum tolerable conditions. Remaining pavement life was calculated by the method used in the 1970-1990 Highway Functional Classification and Needs Study Manual and used to determine future pavement deficiencies.

(e) Cross-Section or Shoulder Deficiency

A deficiency for roadway cross-section or shoulders occurs when the shoulders are not wide enough or of the proper type. Drainage deficiencies occurred when the drainage system was inadequate for the type of system under analysis.

In addition to the above categories, railroad crossings and structures were compared with minimum tolerable conditions to determine deficiencies.

(3) Improvement Types

The improvement types that were applied to the deficient section based upon the kind of deficiency occurring were grouped into the following categories:

(a) New Location

New location is the construction of a new facility on a new location. This improvement is required when the existing location is unsatisfactory because of right-of-way or terrain limitations and reconstruction on the existing alignment is not feasible. New roads are also in this category.

(b) Reconstruction

Reconstruction is the upgrading of a facility on the same alignment. Additional right-of-way was acquired if needed for the improved facility and was available. Most of the improvements were reconstruction, because this is the type of improvement most commonly done.

(c) Isolated Reconstruction

The correction of isolated roadway sections that are causing intolerable operating or safe speed is called isolated reconstruction. Such corrections are considered to be accomplished on essentially the existing alignment and right-of-way.

(d) Widening

Any widening of a roadway section on existing alignment up to the width of adding an additional lane. (Adding lanes is a reconstruction improvement.) Additional right-of-way was usually required for this improvement type.

(e) Resurfacing

The application of a plant mix overlay over the full width of existing pavement. This improvement was done when all characteristics of the road except pavement were satisfactory.

(4) Railroad Crossings

The adequacy of existing and the need for additional railroad crossing protection was determined from exposure factors resulting from 1990 traffic. The type of railroad crossings required for various levels of exposure factors was provided in the Study Manual for the 1970-1990 Study. This table is shown in Appendix A.

(5) Structures

Structure deficiencies are determined from the minimum tolerable conditions in the same manner as roadway deficiencies. Improvements are either widening of the existing structure, complete replacement, or the construction of a new structure where none presently exists. A widening type improvement occurs only when the width to be widened is less than 1/3 of the total required width of the structure. Widening any more than this is not economically feasible. All structures having loading deficiencies require total replacement.

I. UNIT AND PER–MILE COSTS

After the improvement for each section was established, the cost for the improvement was found by multiplying the section length by the per-mile cost for the improvement. The per-mile costs were developed from actual construction costs for projects bid during the five-year period from 1968 through 1973. Structures costs were developed on a unit cost-per-square-foot of improved structures for widening of existing structures and complete replacement or new structures. A detailed development of the per-mile costs is contained in Appendix B.

J. MAINTENANCE COSTS

(1) General

Revised per-mile maintenance costs for each functionally classified system were developed from state summaries of actual on-the-road maintenance costs provided by the State Highway Department, and the *County and Local Road Fiscal Report* for fiscal year 1972. Interstate, primary, and secondary maintenance expenditures were related to the functionally classified system by assuming that: (1) Interstate maintenance costs were directly equivalent to adjusted in-

terstate expenditures. Adjustments were made to account for the fact that the interstate system as a whole has not as yet reached its average maintenance life. The average life was determined from a study of interstate projects made for the 1970-1990 Study; (2) Principal arterial maintenance costs were a combination of adjusted interstate and direct primary expenditures; (3) Minor arterial maintenance costs were a combination of direct primary and secondary expenditures; and (4) Collector maintenance costs were directly equivalent to secondary expenditures.

Urban maintenance costs were developed from actual expenditures in 13 urban areas and rural costs were developed by subtracting the urban costs from the state totals. Mileages from the 1970-1990 Study were used to proportion the costs by functional system.

An administrative and overhead factor was developed by comparing the total amount budgeted for maintenance in 1972 to the state total on-the-road expenditures for 1972. The per-mile maintenance costs were expanded by this amount to bring the total into agreement with the budgeted amount.

Local road and street maintenance costs were developed by dividing the total expenditures by the 1972 Road Log mileages. Maintenance costs for local interstate frontage roads are included in the local road analysis. A summary of the annual per-mile maintenance costs as reviewed and approved by the Maintenance Division of the Montana Department of Highways is given in Table No. 17.

TABLE NO. 17

ANNUAL PER–MILE MAINTENANCE COSTS

Functional System	Annual Per-Mile Cost 4-lane	2-lane
Rural		
Interstate	$2,411/mi	$1,930/mi
Principal Arterials	2,884	2,309
Minor Arterials	2,804	2,245
Collectors (Major and Minor)	1,358	1,087
Local Roads	n/a	572
Urban		
Interstate	8,044	6,438
Principal Arterials	6,108	4,888
Minor Arterials	3,855	3,085
Collectors	3,538	2,832
Local Streets	n/a	1,994

K. ADMINISTRATIVE COSTS

Administrative costs are developed as a percentage of the total construction and maintenance costs. Since it was judged that very little change had occurred since the 1970-1990 Study, the percentages developed for that study were left unchanged. These percentages are listed in Table No. 18.

TABLE NO. 18

ADMINISTRATION COSTS AS A PERCENT OF CONSTRUCTION

Urban & Rural Functional System	Rural	Urbanized	Small Urban
Principal Arterials	6.75	6.75	6.75
Minor Arterials	7.83	7.67	6.50
Collectors	8.92	8.59	6.26
Local Roads or Streets	10.00	9.51	6.01

L. SECOND–GENERATION COSTS

Second-generation costs are those costs that occur during the study period after an improvement has been made. These costs are limited to resurfacing only, since the initial improvement would have brought the section up to standard in all other respects.

A 14-year pavement life has been assigned to all paved surface. Therefore, all sections having improvements scheduled on or before 1980 have second-generation resurfacing costs included in their total needs.

M. NEEDS ANALYSIS ON RURAL MINOR COLLECTORS AND URBAN COLLECTORS

The rural minor collectors and urban collectors were not anticipated to be on the federal-aid system. Consequently, the importance of these systems was not emphasized in this study. Needs on these systems were estimated by updating the data on the sampled worksheets taken during the 1970-1990 Study (approximately 10% of each system's mileage) and expanding the sampled needs to total state-wide needs for these systems.

N. NEEDS ANALYSIS ON LOCAL ROADS AND STREETS

In the 1970-1990 Study, the needs for local roads and streets were estimated by a *mass analysis* procedure using survivor curves to determine deficiencies. This procedure was not compatible with the method used for other functional systems. For this study, the data on the sampled local roads and streets (approximately 5%) obtained for the 1970-1990 Study was used, but the procedure for estimating needs was done on a per-mile basis. This method makes the estimate for local roads and

streets compatible with the other functional systems. A detailed description of the needs analysis for local roads and streets is contained in Appendix C.

O. SUMMARY OF NEEDS ANALYSIS

(1) Consistency Tests

To insure that the needs analysis is consistent with proposed improvements, several consistency checks were made. Proposed improvements in both urban and rural areas were compared with projects proposed or scheduled by the project control officer of the Department of Highways. In addition, maps were prepared on future two-lane and four-lane roads in the state so that individual characteristics of a single section would not induce inconsistencies in the highway systems. The proposed four-lane routes in Montana as identified by this needs study are shown in Figure No. 11.

(2) Cost Comparisons

In addition to the consistency checks, cost comparisons were made with proposed projects, particularly those routes on the priority primary system. The cost comparisons came out to be within reasonable limits of accuracy.

(3) Summary

Tables No. 19 and 20 summarize the results of the Needs and Improvements Analysis. The costs shown include construction, engineering, maintenance, administration, and second-generation needs. In other words, the total needs for all highways in the state regardless of jurisdictional responsibility.

(4) Conclusion

Data on available revenue for highway investment was developed for the 1974 National Transportation Study. Assuming approximately the same level of investment as is currently being expended, approximately $3,268,000,000 in 1972 dollars will be available to expend on highway investments for the 20-year period from 1974 through 1994. This includes annual funds (funds used for annual costs such as maintenance and administration) and construction funds (funds used for actual construction). The available funds are shown in Table No. 21.

Comparing the estimate of $8,334,409,000 needed for highway investment for the 20-year period 1974 to 1994 with the estimated revenue of $3,268,000,000 available for investment in the same period, it is seen that available funding will be about 5 billion dollars short of satisfying the needs. Or, in other words, only about 40% of the identified needs can be satisfied by available funding.

This data presents the obvious need for establishing a valid priority programming system. It is imperative that investments be made wisely to obtain the maximum benefit from the in-

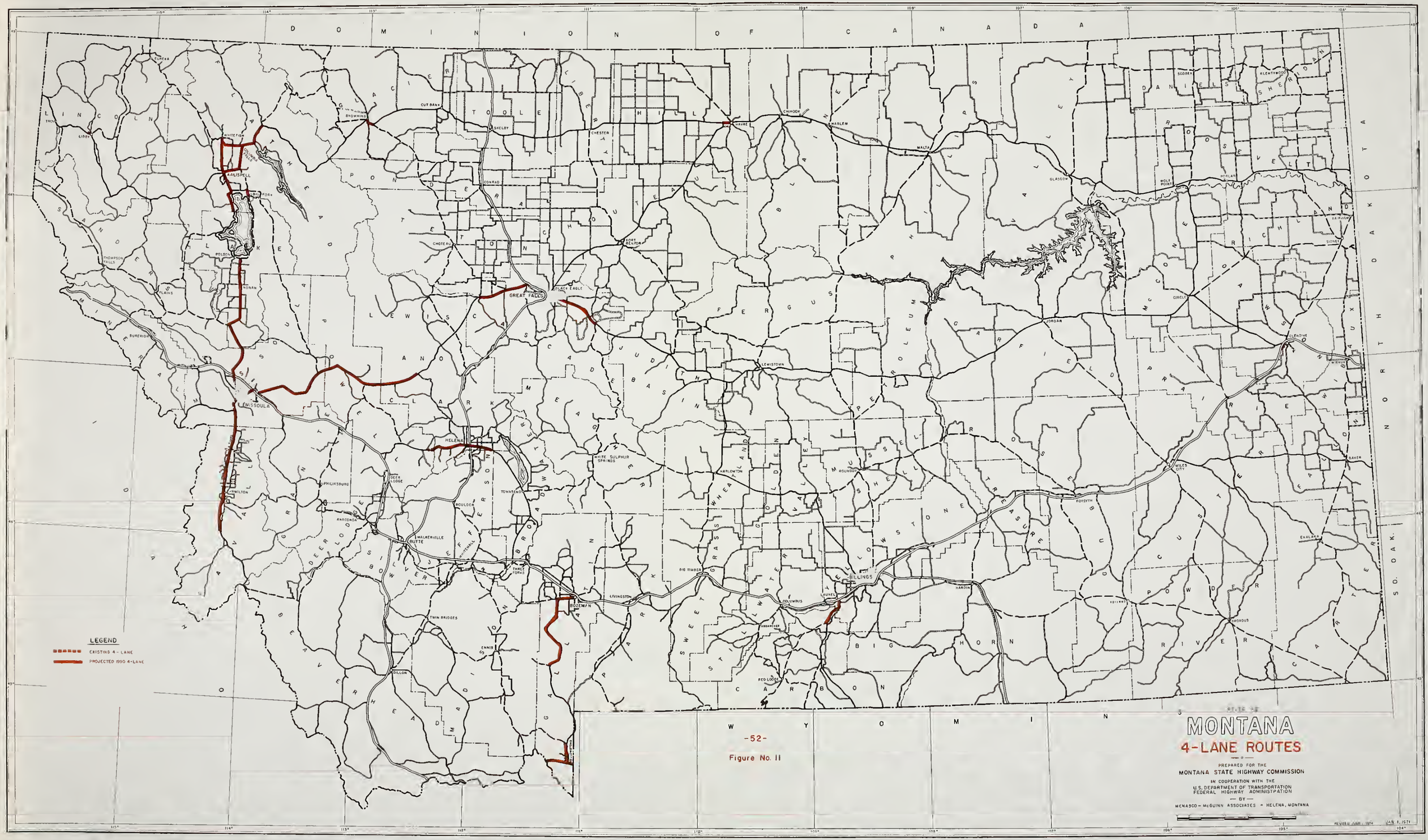

DOMINION OF CANADA
LEGEND
EXISTING 4 - LANE
PROJECTED 1990 4-LANE
MONTANA
4-LANE ROUTES
PREPARED FOR THE
MONTANA STATE HIGHWAY COMMISSION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
— BY —
MENASCO - McGUINN ASSOCIATES • HELENA, MONTANA
GREAT FALLS
MISSOULA
HELENA
BILLINGS
BOZEMAN
BUTTE
KALISPELL
HAVRE
GLASGOW
LEWISTOWN
MILES CITY
SO. DAK.
NORTH DAKOTA
WYOMING

Figure No. 11

TABLE NO. 19

INDIVIDUAL URBAN FUNCTIONAL SYSTEMS NEEDS

Functional Classification	1990 Miles	Deficient Miles	Administration Needs ($1000)	Maintenance Needs ($1000)	Construction Needs ($1000)	2nd Generation Needs ($1000)	Total Needs ($1000)
Billings							
Interstate	13.0	*	171	2,091	448	1,543	4,253
Other Principal Arterials	52.4	50.1	1,924	5,853	22,643	2,826	33,246
Minor Arterials	54.1	54.1	2,382	3,520	27,561	2,700	36,163
Collectors	64.0	64.0	2,148	3,625	28,190	2,910	36,873
Local Streets	444.8	415.3	11,128	17,738	99,291	**	128,157
Total	628.3	583.5	17,753	32,827	178,133	9,979	238,692
Great Falls							
Interstate	6.4	*	79	1,030	147	760	2,016
Other Principal Arterials	29.8	29.8	1,247	3,300	15,190	1,727	21,464
Minor Arterials	46.4	45.7	2,179	3,046	25,275	2,244	32,744
Collectors	36.2	36.2	1,030	2,050	13,210	1,438	17,728
Local Streets	303.4	283.7	7,195	12,102	63,565	**	82,862
Total	422.2	395.4	11,730	21,528	117,387	6,169	156,814
Missoula							
Interstate	7.6	*	83	1,223	6	902	2,214
Other Principal Arterials	24.4	23.3	1,038	2,789	12,568	1,619	18,014
Minor Arterials	41.0	39.7	1,560	2,538	17,799	2,000	23,897
Collectors	44.2	44.2	1,675	2,503	22,315	2,118	28,611
Local Streets	420.4	407.8	12,527	16,767	114,964	**	144,258
Total	537.6	515.0	16,883	25,820	167,652	6,639	216,994
Small Urban (5,000-50,000)							
Interstate	24.7	*	366	3,974	1,445	2,932	8,717
Other Principal Arterials	95.5	90.2	3,615	10,548	42,824	6,576	63,563
Minor Arterials	138.0	136.0	5,456	8,651	62,930	7,750	84,787
Collectors	141.4	141.4	2,952	8,009	39,151	7,985	58,097
Local Streets	1,038.9	973.9	15,111	41,432	210,009	**	266,552
Total	1,438.5	1,341.5	27,500	72,614	356,359	25,243	481,716

* All urban interstate is complete; construction needs indicate safety projects, not deficiencies.

** Second-generation costs not applicable to local roads and streets because low traffic volume results in longer pavement life expectancy.

TABLE NO. 20

FUNCTIONAL SYSTEMS NEEDS SUMMARIES

Functional Classification	1990 Miles	Deficient Miles	Administration Needs ($1000)	Maintenance Needs ($1000)	Construction Needs ($1000)	2nd Generation Needs ($1000)	Total Needs ($1000)
TOTAL URBAN FUNCTIONAL SYSTEM NEEDS							
Interstate	51.7	0	699	8,318	2,046	6,137	17,200
Principal Arterials	202.1	193.4	7,824	22,490	93,225	12,748	136,287
Minor Arterials	279.5	275.5	11,577	17,755	133,565	14,694	177,591
Collectors	285.8	285.8	7,805	16,187	102,866	14,451	141,309
Local Streets	2,207.5	2,080.7	45,961	88,039	487,829	0	621,829
Total	3,026.6	2,835.4	73,866	152,789	819,531	48,030	1,094,216
RURAL FUNCTIONAL SYSTEM NEEDS							
Interstate	1,138.5	488.7	23,523	76,409	272,077	51,336	423,345
Principal Arterials	1,989.1	1,585.5	36,021	97,777	435,822	94,267	663,887
Minor Arterials	3,852.2	3,301.6	46,820	173,597	423,569	133,939	777,925
Major Collectors	5,810.5	4,829.1	49,045	127,743	423,960	164,324	765,072
Minor Collectors	10,464.3	7,795.9	89,469	225,659	774,925	292,885	1,382,938
Local Roads	44,676.2	44,676.2	293,366	511,094	2,422,566	0	3,227,026
Total	67,930.8	62,677.0	538,244	1,212,279	4,752,919	736,751	7,240,193
TOTAL FUNCTIONAL SYSTEM NEEDS							
Interstate	1,190.2	488.7	24,222	84,727	274,123	57,473	440,545
Principal Arterials	2,191.2	1,778.9	43,845	120,267	529,047	107,015	800,174
Minor Arterials	4,131.7	3,577.1	58,397	191,352	557,134	148,633	955,516
Collectors	16,560.6	12,910.8	146,319	369,589	1,301,751	471,660	2,289,319
Local Roads & Streets	46,883.7	46,756.9	339,327	599,133	2,910,395	0	3,848,855
Total Needs	70,957.4	65,512.4	612,110	1,365,068	5,572,450	784,781	8,334,409

vestment in our highway systems. It is also pointed out that a substantial part of the investment in highways is on off-system roads. Therefore, it would behoove agencies other than the State to pay proper attention to highway planning and to establish their priorities in a logical manner.

The background data used in developing this study is on file at the Planning and Research Bureau–Department of Highways in Helena. Other agencies desiring to use the criteria and information may examine the data at this office upon request.

TABLE NO. 21

AVAILABLE FUNDS FOR HIGHWAY INVESTMENT
FOR THE TWENTY–YEAR PERIOD 1974 TO 1995

Agency	Construction Funds ($1000)	Annual Funds ($1000)	Total ($1000)
State	$ 251,000	$ 501,000	$ 752,000
FHWA Federal	987,000	0	987,000
Other Federal	508,000	240,000	748,000
Local	88,000	448,000	536,000
Private	245,000	0	245,000
Total	$2,079,000	$1,189,000	$3,268,000

APPENDIX A

TYPICAL SECTIONS

APPENDIX A

I. TYPICAL SECTIONS

A. Design Standards

It has been previously stated that considerable effort was directed toward developing design standards that reflect those currently being used throughout the state. The basis for this effort was Chapter One of the *Road Design Manual*, Montana Department of Highways. Because the standards in this manual are given with respect to the Federal-Aid System of classification, the primary concern was to correlate them with the functional classification system. This was done with the assistance of the Preconstruction Section with due regard given to the Federal Highway Administration standards established in the 1970-1990 Study. The resulting design standards used throughout the cost analysis are shown in Tables A-1 through A-5. It was agreed that the urban design standards given in the 1970-1990 Study were representative of normal urban practice and required no revision so far as this study is concerned.

B. Average Pavement Designs

In order to compute the quantities necessary to determine the cost per mile for base and surfacing, it was necessary to develop various pavement designs with respect to the design standards. This was accomplished using the *Surfacing Design Procedure*, Montana Department of Highways. Certain variable factors needed to arrive at reasonable average designs were obtained with assistance from the Surfacing Design Engineer (MDH). The analysis and resulting pavement designs are shown in Tables A-4 and A-5.

C. Typical Sections and Quantities Per Mile

Having developed the design standards and average pavement designs, it was then possible to compute the base and surfacing quantities associated with each typical section. These quantities were computed according to the constants and procedures given in Chapter Nine of the *Road Design Manual* (MDH) and the results are shown on the individual typical section sheets included in this appendix.

TABLE A-1

PROPOSED RURAL DESIGN STANDARDS

FUNCTIONAL CLASSIFICATION	PRIN. ART.			MINOR ARTERIALS																		COLLECTORS																	
A.D.T. GROUP	ALL			0-100			100-450			450-700			700-1400			1400-2800			2800+			0-100			100-450			450-700			700-1400			1400-2800			2800+		
DESIGN STANDARD NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
TERRAIN	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M
MAXIMUM DESIGN SPEED, M.P.H.	70	60	50	70	60	50	70	60	50	70	60	50	70	60	50	70	60	50	70	60	50	60	50	40	60	50	40	70	60	50	70	60	50	70	60	50	70	60	50
MAXIMUM DEGREE OF CURVATURE	3.5	5	7.5	3.5	5	7.5	3.5	5	7.5	3.5	5	7.5	3.5	5	7.5	3.5	5	7.5	3.5	5	7.5	5	7.5	12	5	7.5	12	3.5	5	7.5	3.5	5	7.5	3.5	5	7.5	3.5	5	7.5
DESIREABLE STOPPING SIGHT DISTANCE, FT.	850	650	450	850	650	450	850	650	450	850	650	450	850	650	450	850	650	450	850	650	450	650	450	300	650	450	300	850	650	450	850	650	450	850	650	450	850	650	450
MINIMUM PASSING SIGHT DISTANCE, FT.	2500	2100	1800	2500	2100	1800	2500	2100	1800	2500	2100	1800	2500	2100	1800	2500	2100	1800	2500	2100	1800	2100	1800	1500	2100	1800	1500	2500	2100	1800	2500	2100	1800	2500	2100	1800	2500	2100	1800
MAXIMUM GRADIENT, %	3	4	5	3	5	6	3	5	6	3	5	6	3	5	6	3	5	6	3	4	5	5	6	7	5	6	7	3	5	6	3	5	6	3	5	6	3	5	6
NUMBER OF LANES	NOTE (1)			2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	NOTE (1)			2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
MEDIAN WIDTH, FT.	36	36	14																36	36	14																		
2-LANE ROADWAY WIDTH, FT.	44	44	44	28	28	28	28	28	28	30	30	28	36	34	34	40	40	40	44	44	44	26	26	26	28	28	28	30	30	28	36	34	34	40	40	40	44	44	44
SURFACING TYPE (SEE NOTE (2))																																							
R·O·W WIDTH (SEE NOTE (3))																																							
STRUCTURES: WIDTH (SEE NOTE (4))																																							
VERTICAL CLEARANCE, FT.	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
LOADING	HS20-44			HS20-44			HS20-44			HS20-44			HS20-44			HS20-44			HS20-44			HS15-44			HS15-44			HS20-44			HS20-44			HS20-44			HS20-44		

SOURCE: *ROAD DESIGN MANUAL*, MONTANA DEPARTMENT OF HIGHWAYS

NOTES

(1) MULTI-LANE FACILITIES TO BE PROVIDED DEPENDING UPON DESIGN CAPACITY AS FOLLOWS:

	DESIGN CAPACITY, V.P.H. per LANE		
% TRUCKS	0	10	20
FLAT	1000	910	330
ROLLING	1000	770	630
MNT'OUS	1000	710	500

SOURCE: *A POLICY ON GEOMETRIC DESIGN OF RURAL HIGHWAYS*, 1965, AASHO.

(2) GENERALLY 'HIGH' TYPE SURFACING, i.e. mixed bituminous or bituminous penetrotion surface on o flexible or rigid base hoving o totol combined thickness of seven inches or more. LOW VOLUME COLLECTORS MAY JUSTIFY THE USE OF A GRAVEL SURFACE DEPENDING ON LOCAL CONDITIONS.

(3) AS REQUIRED FOR TYPE OF CONSTRUCTION PROPOSED, WITH REGARD TO THE RECOMMENDATIONS PERTAINING TO SLOPES AND RECOVERY AREAS IN THE 1967 AASHO 'YELLOW BOOK', *HIGHWAY DESIGN AND OPERATIONAL PRACTICES RELATED TO HIGHWAY SAFETY.*

(4) GENERALLY, STRUCTURES WILL BE FULL ROADWAY WIDTH (including shoulders), WITH EXCEPTIONS IN ACCORDANCE WITH AASHO STANDARDS.

(5) THE DESIGN STANDARDS SHOWN ABOVE ARE INTENDED AS A GUIDE FOR PREPARING THE ESTIMATED COST FOR NEEDED IMPROVEMENTS IN CONJUNCTION WITH THIS STUDY. THEY ARE NOT INTENDED TO ESTABLISH THE CRITERIA FOR ANY PARTICULAR DESIGN SITUATION.

(6) SEE TABLE A-3 FOR RAILROAD CROSSING CRITERIA

TABLE NO. A-2

URBAN DESIGN STANDARDS

Functional Systems	PRINCIPAL ARTERIAL STREETS		MINOR ARTERIAL STREETS		COLLECTOR STREETS
Urbanized Areas	40		41		42
Small Urban	43		44		45
Urban-in-Rural	46		47		48
Type of Area	Outlying Area	Built-up Area	Outlying Area	Built-up Area	All
Design Speed (mph)	40	50	30	40	30
Access Control	Partial		None		None
Median Width	Minimum of 6 ft. on Principal Arterials. At least 16 ft. where left-turn bays are provided.				
Lane Width (ft.)	12		12		12
Number of Travel Lanes	To be determined by capacity analysis.				
Curb Parking Lanes	Where R/W is available, parking lanes should be provided on both sides. When parking is deleted, curbs to be set back 2 ft. from traveled lanes.				
Surface Type	Surfacing design to be determined by analysis; see Table A-5.				
Cross Section	Typical section shall include curb and gutter, sidewalks, and enclosed drainage.				
Right-of-Way Width (ft.)	As necessary for type of construction proposed, giving due consideration to providing border strips of 8 to 12 ft., particularly in residential areas. See *A Policy on Design of Urban Highways and Arterial Streets*, 1973, AASHO "Red Book."				
Railroad Crossing Protection	See Table A-3.				
Structures:					
Width	For structures less than 200 ft. in length, full approach cross section shall be carried on structure. Parking lanes shall be deleted on structures over 200 ft. in length. Sidewalks provided in any case.				
Vertical Clearance (ft.)	16		16		14
Loading	HS 20-44		HS 20-44		HS 20-44

Note

The design standards shown above are intended as a guide for estimating the cost of improvements in conjunction with this study. They are not intended to establish the criteria for any particular design situation.

TABLE NO. A-3

RAILROAD CROSSING PROTECTION CRITERIA

Functional System	Grade Separation	Flashing Lights with Gates	Flashing Lights	Reflectorized Signs and Crossbucks
RURAL				
Principal Arterial–	Exposure factors[(1)] above 35,000 and on all fully controlled access routes	Exposure factors above 10,000 (2)	Exposure factors above 1,500 and all mainline tracks	All other crossings
Minor Arterial ––	Exposure factors above 35,000	Exposure factors above 10,000 (2)	Exposure factors above 1,500 for single mainline tracks	All other crossings
Collector –––––		Exposure factors above 15,000 (2)	Exposure factors above 3,000 for single mainline tracks	All other crossings
Local –––––––		(2)	Exposure factors above 3,000 for single mainline tracks	All other crossings
URBAN				
Principal Arterial–	Exposure factors above 75,000 and on all fully controlled access routes	Exposure factors above 20,000 (2)	Exposure factors above 3,000 and all mainline tracks	All other crossings
Minor Arterial Street –––––	Exposure factors above 75,000	Exposure factors above 20,000 (2)	Exposure factors above 3,000 for single mainline tracks	All other crossings
Collector Street –		Exposure factors above 30,000 (2)	Exposure factors above 5,000 for single mainline tracks	All other crossings
Local Street –––		(2)	Exposure factors above 5,000 for single mainline tracks	All other crossings

(1) Exposure factor is the product of the 1990 ADT times the number of trains.

(2) Flashing lights and gates should also be installed on multiple mainline tracks or where more than one train may occupy the crossing at the same time and on single tracks where train operating speeds are 70 mph or greater and sight distance is restricted.

Note

In those cases where grade separations were justified but not feasible because of physical limitations, grade separations were not estimated.

TABLE NO. A-4

AVERAGE RURAL PAVEMENT DESIGNS FOR BASE & SURFACING COST ESTIMATE

A.D.T. Group		0 - 100		100 - 450		450 - 700		700 - 1400		1400 - 2800		2800+	
Design A.D.T.		100		450		700		1,400		2,100		3,200	
Equiv. 18^K Wheel Load		2.33		10.50		16.34		32.68		49.01		74.69	
Traffic Index		5.2		6.0		6.2		6.8		7.0		7.4	
COST AREA ONE: Average Soil Support Value = 5.0													
Design Requirements	Total Cover	1.20		1.40		1.45		1.55		1.65		1.75	
	Weighted Structural No.	1.95		2.05		2.40		2.80		3.00		3.20	
Item	Coef.	Thick.	S.N.	Thick.	S.N.	Thick.	S.N.	Thick.	S.N.	Thick.	S.N.	Thick.	S.N.
(1) Plant Mix Bituminous Surfacing, Type 3 –	4.2	.20	.84	.20	.84	.20	.84	.25	1.05	.30	1.26	.35	1.47
(2) Cr. Top Surfacing, Grade 3, Type B ----	1.7	.15	.26	.15	.26	.15	.26	.15	.26	.20	.34	.20	.34
(3) Cr. Base Course, Grade 5, Type A -----	1.7	.60	1.02	.75	1.27	.80	1.36	.90	1.53	.85	1.45	.85	1.45
Total Cover, S.N.		.95	2.12	1.10	2.37	1.15	2.46	1.30	2.84	1.35	3.05	1.40	3.26
Equivalent Slab Thickness		1.23		1.39		1.45		1.66		1.75		1.85	
COST AREA TWO: Average Soil Support Value = 3.0													
Design Requirements	Total Cover	1.60		1.80		1.90		2.05		2.15		2.25	
	Weighted Structural No.	2.60		3.00		3.20		3.65		3.90		4.15	
Item	Coef.	Thick.	S.N.	Thick.	S.N.	Thick.	S.N.	Thick.	S.N.	Thick.	S.N.	Thick.	S.N.
(1) Plant Mix Bituminous Surfacing, Type 3 –	4.2	.20	.84	.20	.84	.25	1.05	.30	1.26	.30	1.26	.35	1.47
(2) Cr. Top Surfacing, Grade 3, Type B ----	1.7	.15	.26	.15	.26	.15	.26	.20	.34	.20	.34	.20	.34
(3) Cr. Base Course, Grade 5, Type A -----	1.7	.95	1.62	1.15	1.95	1.15	1.95	1.20	2.04	1.35	2.30	1.40	2.38
Total Cover, S.N.		1.30	2.72	1.50	3.05	1.55	3.26	1.70	3.64	1.85	3.90	1.95	4.15
Equivalent Slab Thickness		1.61		1.83		1.93		2.14		2.31		2.46	

A. Traffic Data
   1. A.D.T. (Per A.D.T. Group)
   2. % All Trucks = 20%
   3. Directional Factor = 0.50

B. Serviceability Index = 2.5

C. Regional Factor = 2.5

D. Equivalent 18^K Wheel Load Factor = 223.4 per 1000

Note

Procedure taken from *Surfacing Design Procedure*, Montana Department of Highways, July 1972.

TABLE NO. A-5

AVERAGE URBAN PAVEMENT DESIGNS FOR BASE & SURFACING COST ESTIMATE

	URBANIZED AREAS			SMALL URBAN		
	Principal Art.	Minor Art.	Collectors	Principal Art.	Minor Art.	Collectors
1990 Average A.D.T.	10,337	4,770	2,066	4,667	1,619	1,097
1990 Design A.D.T.	12,000	6,000	3,000	6,000	3,000	1,500
Equiv. 18^K Wheel Loading	130.10	65.05	32.53	65.05	27.11	16.26
Traffic Index	7.8	7.2	6.8	7.2	6.8	6.2
DSN	40	41	42	43&46	44&47	45&48
COST AREA ONE: Average Soil Support Value = 5.0 R = 30						
Design Requirements (Total Cover	1.80	1.70	1.60	1.70	1.60	1.45
Design Requirements (Weighted Structural No.	3.43	3.10	2.62	3.10	2.80	2.40

Item	Coef.	Thick.	S.N.	Thick.	S.N.	Thick.	S.N.	Thick.	S.N.	Thick.	S.N.	Thick.	S.N.
(1) Plant Mix Bituminous Surfacing, Type 3 –	4.2	.35	1.47	.30	1.26	.25	1.05	.30	1.26	.25	1.05	.25	1.05
(2) Cr. Top Surfacing, Grade 3, Type B ————	1.7	.25	.42	.20	.34	.20	.34	.20	.34	.20	.34	.20	.34
(3) Cr. Base Course, Grade 5, Type A —————	1.7	.90	1.53	.90	1.53	.80	1.36	.90	1.53	.85	1.44	.65	1.10
Total Cover, S.N.		1.50	3.43	1.40	3.13	1.25	2.75	1.40	3.13	1.30	2.84	1.10	2.50
Equiv. Slab Thickness		1.97		1.81		1.60		1.81		1.66		1.44	
Relative Cost/Ft./Mile		1,964		1,762		1,519		1,762		1,553		1,452	

COST AREA TWO: Average Soil Support Value = 3.0 R = 10													
Design Requirements (Total Cover		2.40		2.20		2.05		2.20		2.05		1.90	
Design Requirements (Weighted Structural No.		4.50		4.05		3.46		4.05		3.65		3.10	
Item	Coef.	Thick.	S.N.	Thick.	S.N.	Thick.	S.N.	Thick.	S.N.	Thick.	S.N.	Thick.	S.N.
(1) Plant Mix Bituminous Surfacing, Type 3 –	4.2	.35	1.47	.30	1.26	.25	1.05	.30	1.26	.25	1.05	.25	1.05
(2) Cr. Top Surfacing, Grade 3, Type B ————	1.7	.25	.42	.25	.42	.20	.34	.25	.42	.20	.34	.20	.34
(3) Cr. Base Course, Grade 5, Type A —————	1.7	1.50	2.55	1.40	2.38	1.20	2.04	1.40	2.38	1.35	2.04	1.10	1.87
Total Cover, S.N.		2.10	4.45	1.95	4.07	1.65	3.43	1.95	4.07	1.80	3.69	1.55	3.26
Equiv. Slab Thickness		2.63		2.42		2.04		2.42		2.21		1.93	
Relative Cost/Ft./Mile		2,366		2,130		1,788		2,130		1,889		1,721	

A. Traffic Data
   1. % All Trucks = 10%
   2. Directional Factor = .5

B. Serviceability Index = 2.5

C. Regional Factor = 2.5

D. Equivalent 18^K Wheel Load Factor = 180.7 per 1000

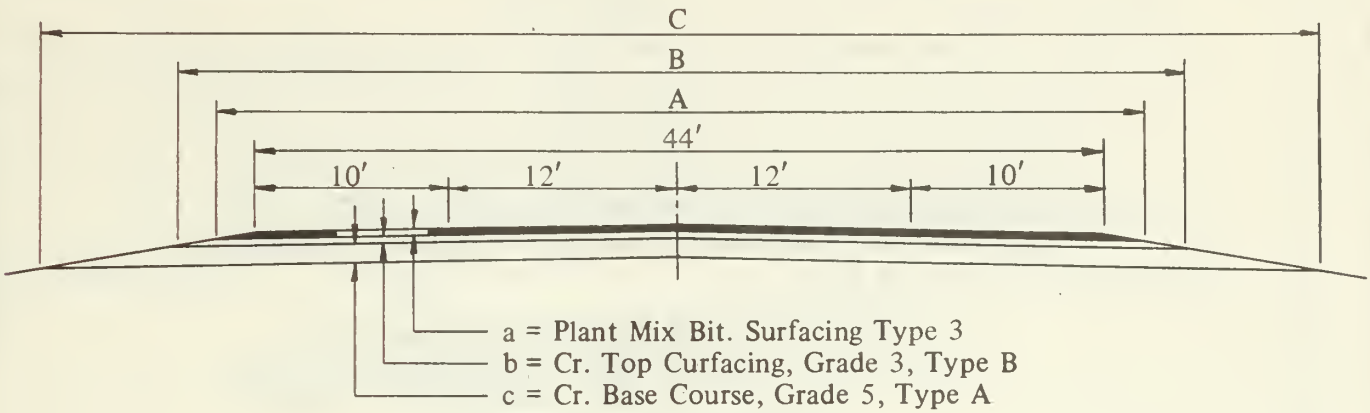
Note

Procedure taken from *Surfacing Design Procedure*, Montana Department of Highways, July 1972.

MONTANA HIGHWAY FUNCTIONAL CLASSIFICATION & NEEDS STUDY - 1974 UPDATE

Design Std. No.s 1, 2, 3; 19, 20, 21; 37, 38, 39 Dwg. No. 1

ADT Group >2800 Pavement Design No. 6 FAP



Typical Section Dimensions

	Plant Mix		Top Surf.		Base Crse.	
	a	A	b	B	c	C
Cost Area 1	0.35	49.0	0.20	51.9	0.85	64.0
Cost Area 2	0.35	48.7	0.20	51.3	1.40	70.0

Typical Section Quantities Per Mile

Course	COST AREA 1			COST AREA 2		
	End Area	Surf. Area	Volume	End Area	Surf. Area	Volume
a. Plant Mix	16.3	27,322.3	3,187.6	16.2	27,154.3	3,168.0
b. Top Surf.	10.1	29,626.5	1,975.1	10.0	29,334.0	1,955.6
c. Base Crse.	49.3	34,026.7	9,640.9	84.9	35,577.2	16,602.7
d. Prime		29,626.5			29,334.0	
e. Tack		29,626.5			29,334.0	

Base & Surfacing Quantities Per Mile

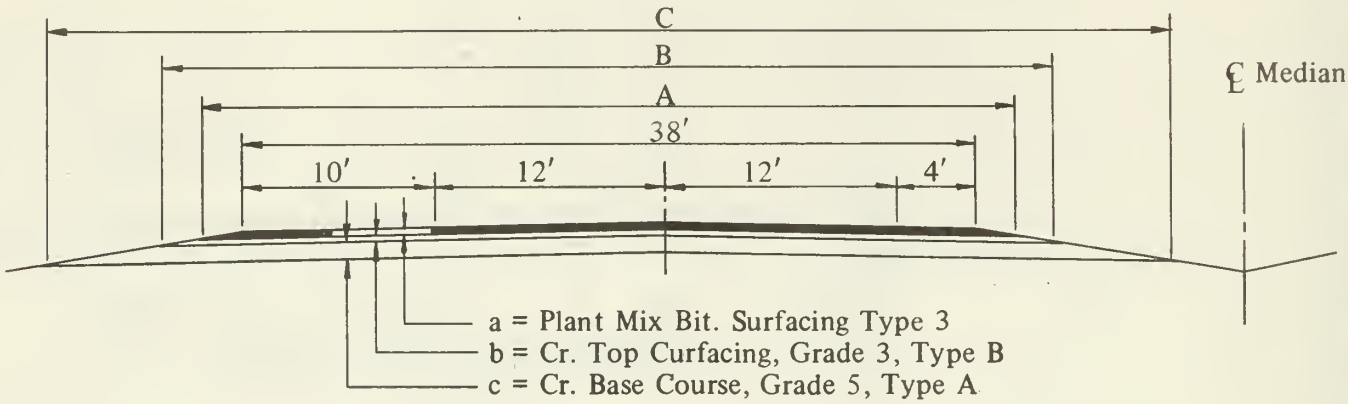
No.	Item	Unit	Cost Area 1 Quantity/Mi.	Cost Area 2 Quantity/Mi.
1	Rolling Surface Courses	Unit	118.4	182.5
2	Water Surface Courses	M. Gal.	537.2	858.3
3	Cr. Base Course, Grade 5, Type A	Ton	17,835.7	30,715.0
4	Cr. Top Surfacing, Grade 3, Type B	Ton	3,653.9	3,617.9
5	Plant Mix Bituminous Surfacing, Type 3	Ton	6,144.1	6,106.3
6	Mineral Filler	Ton	61.4	61.1
7	Asphalt Cement 120 - 150	Ton	399.4	396.9
8	Liquid Asphalt MC-70 (Prime)	Ton	37.8	37.4
9	Emulsified Asphalt SS-1 (Tack)	Gal.	2,962.6	2,933.4
10	Median Guard Rail, Concrete Pre-Cast	L.F.		
11	Median Curb	L.F.		
12	Concr. Curb and Gutter	L.F.		
13	Sidewalks	Sq. Ft.		

MONTANA HIGHWAY FUNCTIONAL CLASSIFICATION & NEEDS STUDY - 1974 UPDATE

Design Std. No.s 1, 2; 19, 20 (4-lane) Dwg. No. 2

ADT Group >2800 Pavement Design No. 6 FAI

Half Section



Typical Section Dimensions

	Plant Mix		Top Surf.		Base Crse.	
	a	A	b	B	c	C
Cost Area 1	0.35	43.0	0.20	45.9	0.85	58.0
Cost Area 2	0.35	42.7	0.20	45.3	1.40	64.0

Typical Section Quantities Per Mile

Course	COST AREA 1			COST AREA 2		
	End Area	Surf. Area	Volume	End Area	Surf. Area	Volume
a. Plant Mix	28.4	47,604.0	5,553.8	28.2	47,268.0	5,514.6
b. Top Surf.	17.8	52,212.0	3,480.0	17.6	51,627.0	3,441.8
c. Base Crse.	88.4	61,013.6	17,287.2	153.0	64,114.2	29,920.0
d. Prime		52,212.0			51,627.0	
e. Tack		52,212.0			51,627.0	

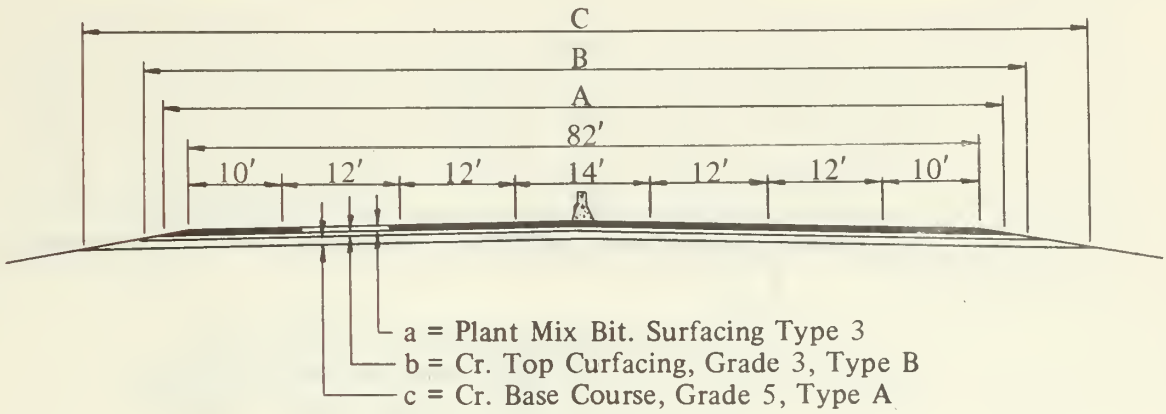
Base & Surfacing Quantities Per Mile

No.	Item	Unit	Cost Area 1 Quantity/Mi.	Cost Area 2 Quantity/Mi.
1	Rolling Surface Courses	Unit	211.4	327.6
2	Water Surface Courses	M. Gal.	960.6	1,543.0
3	Cr. Base Course, Grade 5, Type A	Ton	31,981.4	55,352.0
4	Cr. Top Surfacing, Grade 3, Type B	Ton	6,439.4	6,367.4
5	Plant Mix Bituminous Surfacing, Type 3	Ton	10,705.0	10,629.4
6	Mineral Filler	Ton	107.0	106.3
7	Asphalt Cement 120 - 150	Ton	695.8	691.0
8	Liquid Asphalt MC-70 (Prime)	Ton	66.6	65.8
9	Emulsified Asphalt SS-1 (Tack)	Gal.	5,221.2	5,162.6
10	Median Guard Rail, Concrete Pre-Cast	L.F.		
11	Median Curb	L.F.		
12	Concr. Curb and Gutter	L.F.		
13	Sidewalks	Sq. Ft.		

MONTANA HIGHWAY FUNCTIONAL CLASSIFICATION & NEEDS STUDY - 1974 UPDATE

Design Std. No.s 3 & 21 (4-lane) Dwg. No. 3

ADT Group >2800 Pavement Design No. 6 FAI



Typical Section Dimensions

	Plant Mix		Top Surf.		Base Crse.	
	a	A	b	B	c	C
Cost Area 1	0.35	87.0	0.20	89.9	0.85	102.0
Cost Area 2	0.35	86.7	0.20	89.3	1.40	108.0

Typical Section Quantities Per Mile

Course	COST AREA 1			COST AREA 2		
	End Area	Surf. Area	Volume	End Area	Surf. Area	Volume
a. Plant Mix	29.6	49,614.9	5,788.4	29.5	49,447.7	5,768.9
b. Top Surf.	17.7	51,919.5	3,461.3	17.6	51,627.0	3,441.8
c. Base Crse.	81.6	56,319.9	15,957.3	138.1	57,870.4	27,006.2
d. Prime		51,919.5			51,627.0	
e. Tack		51,919.5			51,627.0	

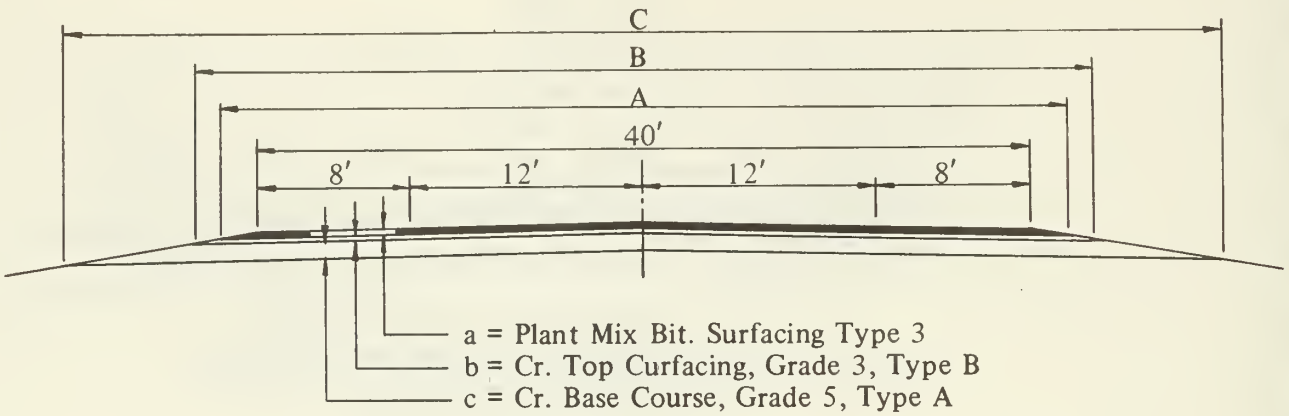
Base & Surfacing Quantities Per Mile

No.	Item	Unit	Cost Area 1 Quantity/Mi.	Cost Area 2 Quantity/Mi.
1	Rolling Surface Courses	Unit	198.8	300.7
2	Water Surface Courses	M. Gal.	898.1	1,408.2
3	Cr. Base Course, Grade 5, Type A	Ton	29,521.0	49,961.5
4	Cr. Top Surfacing, Grade 3, Type B	Ton	6,403.4	6,367.3
5	Plant Mix Bituminous Surfacing, Type 3	Ton	11,157.2	11,119.6
6	Mineral Filler	Ton	111.6	111.2
7	Asphalt Cement 120 - 150	Ton	725.2	722.8
8	Liquid Asphalt MC-70 (Prime)	Ton	66.2	65.8
9	Emulsified Asphalt SS-1 (Tack)	Gal.	5,191.9	5,162.7
10	Median Guard Rail, Concrete Pre-Cast	L.F.	5,280.0	5,280.0
11	Median Curb	L.F.		
12	Concr. Curb and Gutter	L.F.		
13	Sidewalks	Sq. Ft.		

MONTANA HIGHWAY FUNCTIONAL CLASSIFICATION & NEEDS STUDY - 1974 UPDATE

Design Std. No.s 16, 17, 18; 34, 35, 36 Dwg. No. 4

ADT Group 1400 - 2800 Pavement Design No. 5 FAP



Typical Section Dimensions

	Plant Mix		Top Surf.		Base Crse.	
	a	A	b	B	c	C
Cost Area 1	0.30	44.0	0.20	46.7	0.85	58.0
Cost Area 2	0.30	44.2	0.20	47.0	1.35	66.0

Typical Section Quantities Per Mile

Course	COST AREA 1			COST AREA 2		
	End Area	Surf. Area	Volume	End Area	Surf. Area	Volume
a. Plant Mix	12.6	24,640.0	2,640.0	12.6	24,640.0	2,640.0
b. Top Surf.	9.1	26,694.0	1,779.6	9.1	26,694.0	1,779.6
c. Base Crse.	44.5	30,713.6	8,702.2	76.3	33,157.6	14,920.9
d. Prime		26,694.0			26,694.0	
e. Tack		26,694.0			26,694.0	

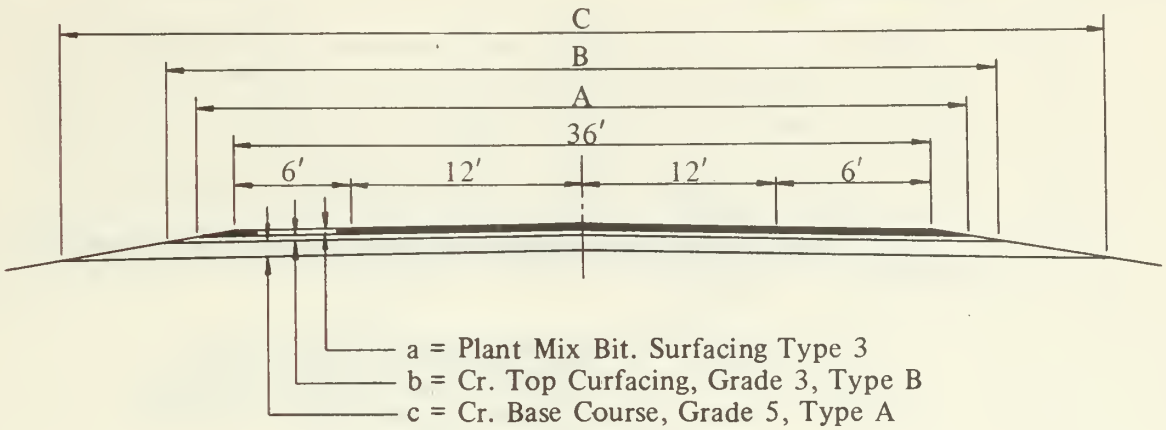
Base & Surfacing Quantities Per Mile

No.	Item	Unit	Cost Area 1 Quantity/Mi.	Cost Area 2 Quantity/Mi.
1	Rolling Surface Courses	Unit	106.8	164.4
2	Water Surface Courses	M. Gal.	484.8	772.4
3	Cr. Base Course, Grade 5, Type A	Ton	16,099.1	27,603.7
4	Cr. Top Surfacing, Grade 3, Type B	Ton	3,292.3	3,292.3
5	Plant Mix Bituminous Surfacing, Type 3	Ton	4,749.4	4,749.4
6	Mineral Filler	Ton	47.5	47.5
7	Asphalt Cement 120 - 150	Ton	308.7	308.7
8	Liquid Asphalt MC-70 (Prime)	Ton	34.0	34.0
9	Emulsified Asphalt SS-1 (Tack)	Gal.	2,669.4	2,669.4
10	Median Guard Rail, Concrete Pre-Cast	L.F.		
11	Median Curb	L.F.		
12	Concr. Curb and Gutter	L.F.		
13	Sidewalks	Sq. Ft.		

MONTANA HIGHWAY FUNCTIONAL CLASSIFICATION & NEEDS STUDY - 1974 UPDATE

Design Std. No.s 13 & 31 Dwg. No. 5

ADT Group 700 - 1400 Pavement Design No. 4 FAP



Typical Section Dimensions

	Plant Mix		Top Surf.		Base Crse.	
	a	A	b	B	c	C
Cost Area 1	0.25	39.5	0.15	41.5	0.90	54.0
Cost Area 2	0.30	40.2	0.20	43.1	1.20	60.0

Typical Section Quantities Per Mile

Course	COST AREA 1			COST AREA 2		
	End Area	Surf. Area	Volume	End Area	Surf. Area	Volume
a. Plant Mix	9.4	22,058.4	1,838.2	11.4	22,293.0	2,229.3
b. Top Surf.	6.1	23,858.0	1,192.9	8.3	24,346.5	1,623.1
c. Base Crse.	43.0	28,029.7	8,408.9	61.9	30,262.2	12,104.9
d. Prime		23,858.0			24,346.5	
e. Tack		23,858.0			24,346.5	

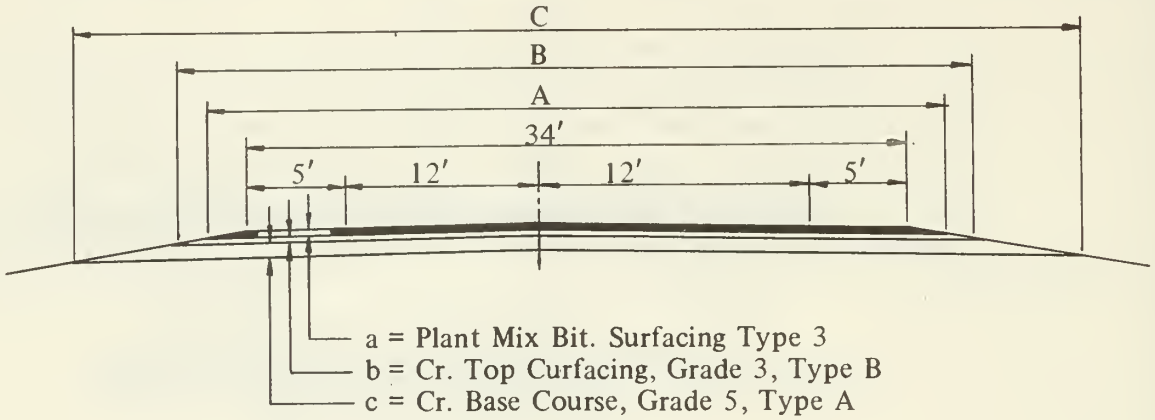
Base & Surfacing Quantities Per Mile

No.	Item	Unit	Cost Area 1 Quantity/Mi.	Cost Area 2 Quantity/Mi.
1	Rolling Surface Courses	Unit	95.4	136.0
2	Water Surface Courses	M. Gal.	444.1	634.9
3	Cr. Base Course, Grade 5, Type A	Ton	15,556.5	22,394.1
4	Cr. Top Surfacing, Grade 3, Type B	Ton	2,206.9	3,002.7
5	Plant Mix Bituminous Surfacing, Type 3	Ton	3,543.1	4,297.0
6	Mineral Filler	Ton	35.4	43.0
7	Asphalt Cement 120 - 150	Ton	230.3	279.3
8	Liquid Asphalt MC-70 (Prime)	Ton	30.4	31.0
9	Emulsified Asphalt SS-1 (Tack)	Gal.	2,385.8	2,434.6
10	Median Guard Rail, Concrete Pre-Cast	L.F.		
11	Median Curb	L.F.		
12	Concr. Curb and Gutter	L.F.		
13	Sidewalks	Sq. Ft.		

MONTANA HIGHWAY FUNCTIONAL CLASSIFICATION & NEEDS STUDY - 1974 UPDATE

Design Std. No.s 14, 15; 32, 33 Dwg. No. 6

ADT Group 700 - 1400 Pavement Design No. 4 FAP



Typical Section Dimensions

	Plant Mix		Top Surf.		Base Crse.	
	a	A	b	B	c	C
Cost Area 1	0.25	37.5	0.15	39.5	0.90	52.0
Cost Area 2	0.30	38.2	0.20	41.1	1.20	58.0

Typical Section Quantities Per Mile

Course	COST AREA 1			COST AREA 2		
	End Area	Surf. Area	Volume	End Area	Surf. Area	Volume
a. Plant Mix	8.9	20,884.8	1,740.4	10.80	21,120.0	2,112.0
b. Top Surf.	5.8	22,684.0	1,134.2	7.90	23,173.5	1,544.9
c. Base Crse.	41.2	26,856.3	8,056.9	59.5	29,089.0	11,635.6
d. Prime		22,684.0			23,173.5	
e. Tack		22,684.0			23,173.5	

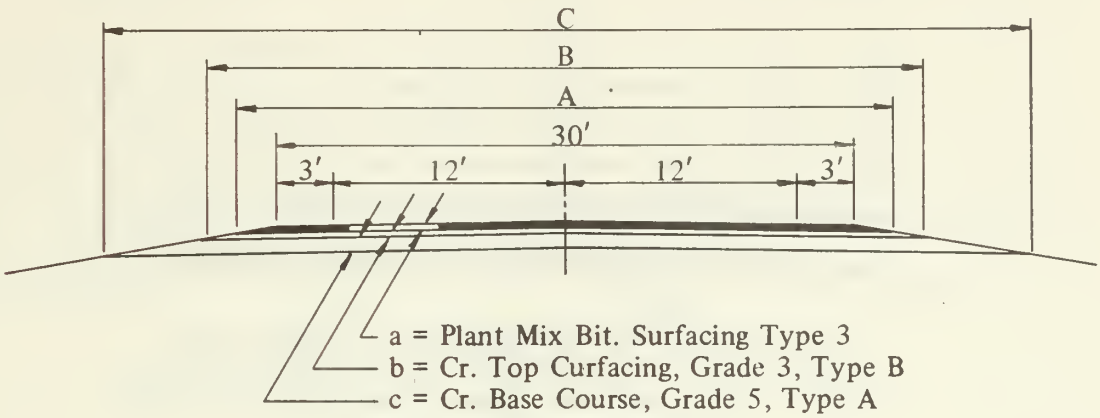
Base & Surfacing Quantities Per Mile

No.	Item	Unit	Cost Area 1 Quantity/Mi.	Cost Area 2 Quantity/Mi.
1	Rolling Surface Courses	Unit	91.3	130.5
2	Water Surface Courses	M. Gal.	425.1	609.6
3	Cr. Base Course, Grade 5, Type A	Ton	14,905.3	21,525.9
4	Cr. Top Surfacing, Grade 3, Type B	Ton	2,098.3	2,858.1
5	Plant Mix Bituminous Surfacing, Type 3	Ton	3,354.6	4,070.9
6	Mineral Filler	Ton	33.5	40.7
7	Asphalt Cement 120 - 150	Ton	218.0	264.6
8	Liquid Asphalt MC-70 (Prime)	Ton	28.9	29.5
9	Emulsified Asphalt SS-1 (Tack)	Gal.	2,268.4	2,317.3
10	Median Guard Rail, Concrete Pre-Cast	L.F.		
11	Median Curb	L.F.		
12	Concr. Curb and Gutter	L.F.		
13	Sidewalks	Sq. Ft.		

MONTANA HIGHWAY FUNCTIONAL CLASSIFICATION & NEEDS STUDY - 1974 UPDATE

Design Std. No.s 10, 11; 28, 29 Dwg. No. 7

ADT Group 450 - 700 Pavement Design No. 3 FAS



Typical Section Dimensions

	Plant Mix		Top Surf.		Base Crse.	
	a	A	b	B	c	C
Cost Area 1	0.20	32.8	0.15	34.9	0.80	46.0
Cost Area 2	0.25	33.5	0.15	35.7	1.15	52.0

Typical Section Quantities Per Mile

Course	COST AREA 1			COST AREA 2		
	End Area	Surf. Area	Volume	End Area	Surf. Area	Volume
a. Plant Mix	6.3	18,480.0	1,232.0	7.9	18,538.8	1,544.9
b. Top Surf.	5.1	19,946.0	997.3	5.2	20,338.0	1,016.9
c. Base Crse.	32.4	23,760.0	6,336.0	50.4	25,711.3	9,856.0
d. Prime		19,946.0			20,338.0	
e. Tack		19,946.0			20,338.0	

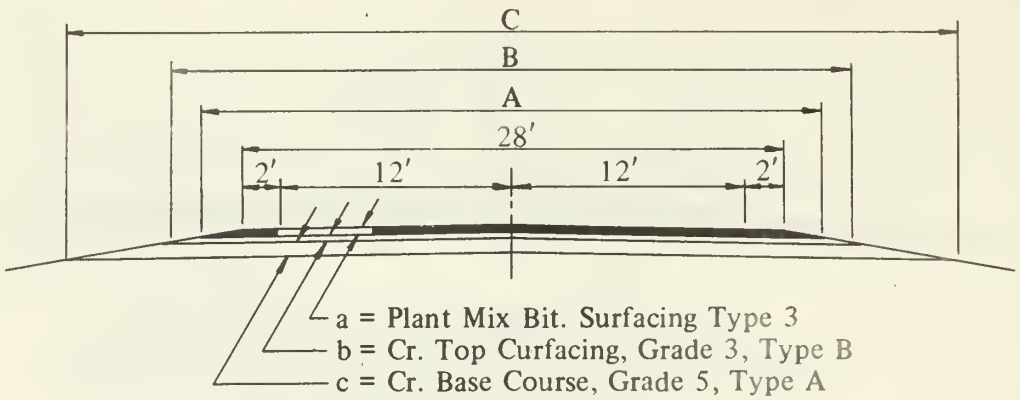
Base & Surfacing Quantities Per Mile

No.	Item	Unit	Cost Area 1 Quantity/Mi.	Cost Area 2 Quantity/Mi.
1	Rolling Surface Courses	Unit	73.4	106.2
2	Water Surface Courses	M. Gal.	339.2	502.9
3	Cr. Base Course, Grade 5, Type A	Ton	11,721.6	18,233.6
4	Cr. Top Surfacing, Grade 3, Type B	Ton	1,845.0	1,881.3
5	Plant Mix Bituminous Surfacing, Type 3	Ton	2,374.7	2,977.8
6	Mineral Filler	Ton	23.7	29.8
7	Asphalt Cement 120 - 150	Ton	154.4	193.6
8	Liquid Asphalt MC-70 (Prime)	Ton	25.4	25.9
9	Emulsified Asphalt SS-1 (Tack)	Gal.	1,994.6	2,033.8
10	Median Guard Rail, Concrete Pre-Cast	L.F.		
11	Median Curb	L.F.		
12	Concr. Curb and Gutter	L.F.		
13	Sidewalks	Sq. Ft.		

MONTANA HIGHWAY FUNCTIONAL CLASSIFICATION & NEEDS STUDY - 1974 UPDATE

Design Std. No.s 12, 30 Dwg. No. 8

ADT Group 450 - 700 Pavement Design No. 3 FAS



Typical Section Dimensions

	Plant Mix		Top Surf.		Base Crse.	
	a	A	b	B	c	C
Cost Area 1	0.20	30.8	0.15	32.9	0.80	44.0
Cost Area 2	0.25	31.5	0.15	33.7	1.15	50.0

Typical Section Quantities Per Mile

Course	COST AREA 1			COST AREA 2		
	End Area	Surf. Area	Volume	End Area	Surf. Area	Volume
a. Plant Mix	5.9	17,307.0	1,153.8	7.4	17,365.2	1,447.1
b. Top Surf.	4.8	18,774.0	938.7	4.9	19,164.0	958.2
c. Base Crse.	30.8	22,586.6	6,023.1	48.1	24,537.9	9,406.2
d. Prime		18,774.0			19,164.0	
e. Tack		18,774.0			19,164.0	

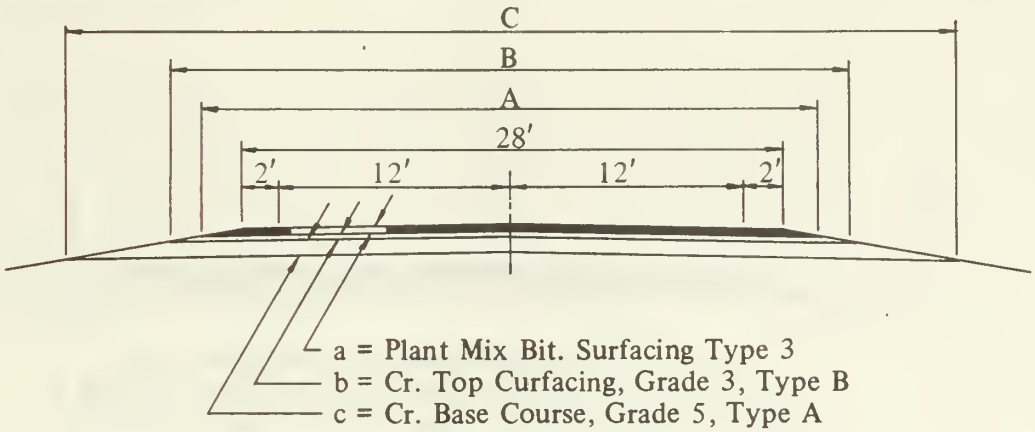
Base & Surfacing Quantities Per Mile

No.	Item	Unit	Cost Area 1 Quantity/Mi.	Cost Area 2 Quantity/Mi.
1	Rolling Surface Courses	Unit	69.6	101.2
2	Water Surface Courses	M. Gal.	322.0	479.4
3	Cr. Base Course, Grade 5, Type A	Ton	11,142.7	17,401.5
4	Cr. Top Surfacing, Grade 3, Type B	Ton	1,736.6	1,772.7
5	Plant Mix Bituminous Surfacing, Type 3	Ton	2,223.9	2,789.3
6	Mineral Filler	Ton	22.2	27.9
7	Asphalt Cement 120 - 150	Ton	144.6	181.3
8	Liquid Asphalt MC-70 (Prime)	Ton	23.9	24.4
9	Emulsified Asphalt SS-1 (Tack)	Gal.	1,877.4	1,916.4
10	Median Guard Rail, Concrete Pre-Cast	L.F.		
11	Median Curb	L.F.		
12	Concr. Curb and Gutter	L.F.		
13	Sidewalks	Sq. Ft.		

MONTANA HIGHWAY FUNCTIONAL CLASSIFICATION & NEEDS STUDY - 1974 UPDATE

Design Std. No.s 7, 8, 9; 25, 26, 27 Dwg. No. 9

ADT Group 100 - 450 Pavement Design No. 2 FAS



Typical Section Dimensions

	Plant Mix		Top Surf.		Base Crse.	
	a	A	b	B	c	C
Cost Area 1	0.20	30.9	0.15	33.1	0.75	44.0
Cost Area 2	0.20	30.7	0.15	32.7	1.15	48.0

Typical Section Quantities Per Mile

Course	COST AREA 1			COST AREA 2		
	End Area	Surf. Area	Volume	End Area	Surf. Area	Volume
a. Plant Mix	5.9	17,307.0	1,153.8	5.9	17,307.0	1,153.8
b. Top Surf.	4.8	18,774.0	938.7	4.8	18,774.0	938.7
c. Base Crse.	28.9	22,606.4	5,651.6	46.4	23,670.8	9,073.8
d. Prime		18,774.0			18,774.0	
e. Tack		18,774.0			18,774.0	

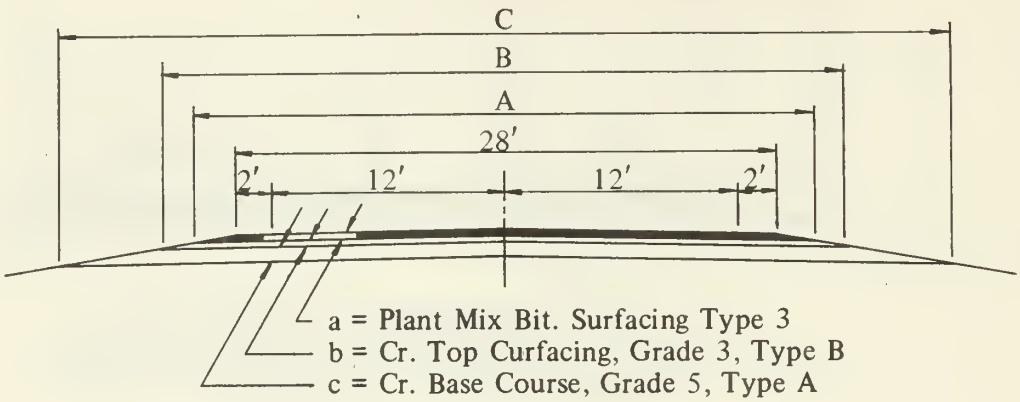
Base & Surfacing Quantities Per Mile

No.	Item	Unit	Cost Area 1 Quantity/Mi.	Cost Area 2 Quantity/Mi.
1	Rolling Surface Courses	Unit	66.2	97.8
2	Water Surface Courses	M. Gal.	304.8	463.1
3	Cr. Base Course, Grade 5, Type A	Ton	10,455.5	16,786.5
4	Cr. Top Surfacing, Grade 3, Type B	Ton	1,736.6	1,736.6
5	Plant Mix Bituminous Surfacing, Type 3	Ton	2,223.9	2,223.9
6	Mineral Filler	Ton	22.2	22.2
7	Asphalt Cement 120 - 150	Ton	144.6	144.6
8	Liquid Asphalt MC-70 (Prime)	Ton	23.9	23.9
9	Emulsified Asphalt SS-1 (Tack)	Gal.	1,877.4	1,877.4
10	Median Guard Rail, Concrete Pre-Cast	L.F.		
11	Median Curb	L.F.		
12	Concr. Curb and Gutter	L.F.		
13	Sidewalks	Sq. Ft.		

MONTANA HIGHWAY FUNCTIONAL CLASSIFICATION & NEEDS STUDY - 1974 UPDATE

Design Std. No.s 4, 5, 6 Dwg. No. 10

ADT Group 0 - 100 Pavement Design No. 1 FAS



Typical Section Dimensions

	Plant Mix		Top Surf.		Base Crse.	
	a	A	b	B	c	C
Cost Area 1	0.20	30.5	0.15	32.4	0.60	40.0
Cost Area 2	0.20	30.8	0.15	32.8	0.95	46.0

Typical Section Quantities Per Mile

Course	COST AREA 1			COST AREA 2		
	End Area	Surf. Area	Volume	End Area	Surf. Area	Volume
a. Plant Mix	5.8	17,013.0	1,134.2	5.9	17,307.0	1,153.8
b. Top Surf.	4.7	18,382.0	919.1	4.8	18,774.0	938.7
c. Base Crse.	21.7	21,218.0	4,243.6	37.4	23,096.2	7,313.8
d. Prime		18,382.0			18,774.0	
e. Tack		18,382.0			18,774.0	

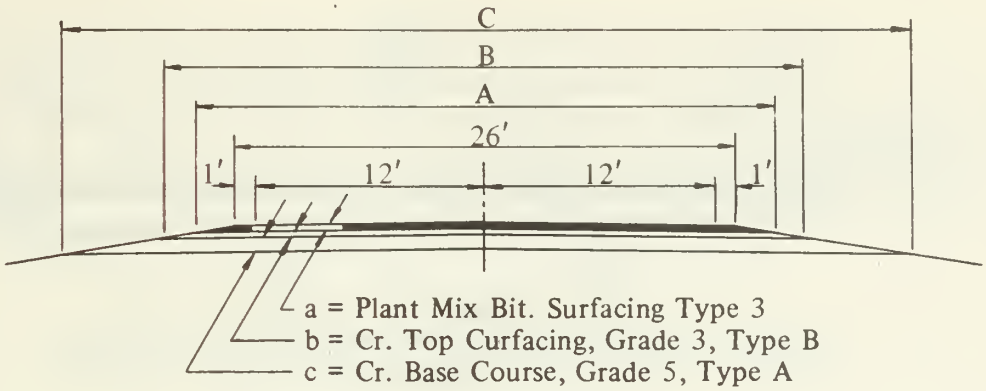
Base & Surfacing Quantities Per Mile

No.	Item	Unit	Cost Area 1 Quantity/Mi.	Cost Area 2 Quantity/Mi.
1	Rolling Surface Courses	Unit	52.9	81.5
2	Water Surface Courses	M. Gal.	238.8	381.7
3	Cr. Base Course, Grade 5, Type A	Ton	7,850.7	13,530.5
4	Cr. Top Surfacing, Grade 3, Type B	Ton	1,700.3	1,736.6
5	Plant Mix Bituminous Surfacing, Type 3	Ton	2,186.2	2,223.9
6	Mineral Filler	Ton	21.9	22.2
7	Asphalt Cement 120 - 150	Ton	142.1	144.6
8	Liquid Asphalt MC-70 (Prime)	Ton	23.4	23.9
9	Emulsified Asphalt SS-1 (Tack)	Gal.	1,838.2	1,877.4
10	Median Guard Rail, Concrete Pre-Cast	L.F.		
11	Median Curb	L.F.		
12	Concr. Curb and Gutter	L.F.		
13	Sidewalks	Sq. Ft.		

MONTANA HIGHWAY FUNCTIONAL CLASSIFICATION & NEEDS STUDY - 1974 UPDATE

Design Std. No.s 22, 23, 24 Dwg. No. 11

ADT Group 0 - 100 Pavement Design No. 1 FAS



Typical Section Dimensions

	Plant Mix		Top Surf.		Base Crse.	
	a	A	b	B	c	C
Cost Area 1	0.20	28.5	0.15	30.4	0.60	38.0
Cost Area 2	0.20	28.8	0.15	30.8	0.95	44.0

Typical Section Quantities Per Mile

Course	COST AREA 1			COST AREA 2		
	End Area	Surf. Area	Volume	End Area	Surf. Area	Volume
a. Plant Mix	5.4	15,840.0	1,056.0	5.5	16,134.0	1,075.6
b. Top Surf.	4.4	17,208.0	860.4	4.5	17,600.0	880.0
c. Base Crse.	20.5	20,044.5	4,008.9	35.5	21,922.7	6,942.2
d. Prime		17,208.0			17,600.0	
e. Tack		17,208.0			17,600.0	

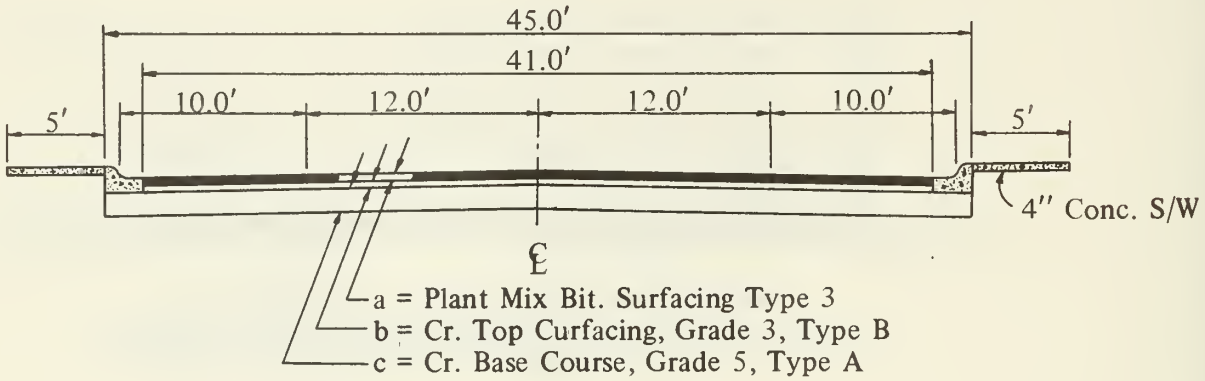
Base & Surfacing Quantities Per Mile

No.	Item	Unit	Cost Area 1 Quantity/Mi.	Cost Area 2 Quantity/Mi.
1	Rolling Surface Courses	Unit	49.0	77.2
2	Water Surface Courses	M. Gal.	225.2	361.8
3	Cr. Base Course, Grade 5, Type A	Ton	7,416.5	12,843.1
4	Cr. Top Surfacing, Grade 3, Type B	Ton	1,591.7	1,628.0
5	Plant Mix Bituminous Surfacing, Type 3	Ton	2,035.4	2,073.2
6	Mineral Filler	Ton	20.4	20.7
7	Asphalt Cement 120 - 150	Ton	132.3	134.8
8	Liquid Asphalt MC-70 (Prime)	Ton	21.9	22.4
9	Emulsified Asphalt SS-1 (Tack)	Gal.	1,720.8	1,760.0
10	Median Guard Rail, Concrete Pre-Cast	L.F.		
11	Median Curb	L.F.		
12	Concr. Curb and Gutter	L.F.		
13	Sidewalks	Sq. Ft.		

MONTANA HIGHWAY FUNCTIONAL CLASSIFICATION & NEEDS STUDY - 1974 UPDATE

Design Std. No.s 40 (2-lane) Urbanized Areas, Principal Arterial Dwg. No. 12

ADT Group All Pavement Design No. 1



Typical Section Dimensions

	Plant Mix		Top Surf.		Base Crse.	
	a	A	b	B	c	C
Cost Area 1	0.35	41	0.25	41	0.90	45
Cost Area 2	0.35	41	0.25	41	1.50	45

Typical Section Quantities Per Mile

Course	COST AREA 1			COST AREA 2		
	End Area	Surf. Area	Volume	End Area	Surf. Area	Volume
a. Plant Mix	14.4 S.F.	24,137.1 S.Y.	2,816.0 C.Y.	14.4 S.F.	24,137.1 S.Y.	2,816.0 C.Y.
b. Top Surf.	10.3 S.F.	24,137.1 S.Y.	2,014.2 C.Y.	10.3 S.F.	24,137.1 S.Y.	2,014.2 C.Y.
c. Base Crse.	40.5 S.F.	26,400.0 S.Y.	7,920.0 C.Y.	67.5 S.F.	26,400.0 S.Y.	13,200.0 C.Y.
d. Prime		24,137.1 S.Y.			24,137.1 S.Y.	
e. Tack		24,137.1 S.Y.			24,137.1 S.Y.	

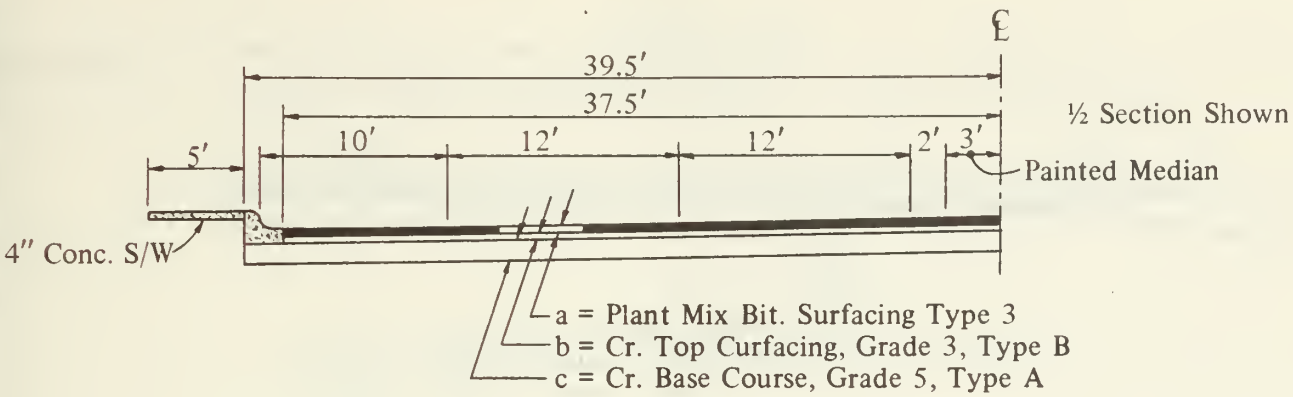
Base & Surfacing Quantities Per Mile

No.	Item	Unit	Cost Area 1 Quantity/Mi.	Cost Area 2 Quantity/Mi.
1	Rolling Surface Courses	Unit	103.1	151.9
2	Water Surface Courses	M. Gal.	459.5	703.7
3	Cr. Base Course, Grade 5, Type A	Ton	14,652.0	24,420.0
4	Cr. Top Surfacing, Grade 3, Type B	Ton	3,726.3	3,726.3
5	Plant Mix Bituminous Surfacing, Type 3	Ton	5,427.8	5,427.8
6	Mineral Filler	Ton	54.3	54.3
7	Asphalt Cement 120 - 150	Ton	352.8	352.8
8	Liquid Asphalt MC-70 (Prime)	Ton	30.8	30.8
9	Emulsified Asphalt SS-1 (Tack)	Gal.	2,413.7	2,413.7
10	Median Guard Rail, Concrete Pre-Cast	L.F.	0	0
11	Median Curb	L.F.	0	0
12	Concr. Curb and Gutter	L.F.	9,800.0	9,800.0
13	Sidewalks	Sq. Ft.	4,880.0	4,880.0

MONTANA HIGHWAY FUNCTIONAL CLASSIFICATION & NEEDS STUDY - 1974 UPDATE

Design Std. No.s 40: 4-lane, 6' Median Dwg. No. 13

ADT Group All Pavement Design No. 1



Typical Section Dimensions

	Plant Mix		Top Surf.		Base Crse.	
	a	A	b	B	c	C
Cost Area 1	0.35	75	0.25	75	0.90	79
Cost Area 2	0.35	75	0.25	75	1.50	79

Typical Section Quantities Per Mile

Course	COST AREA 1			COST AREA 2		
	End Area	Surf. Area	Volume	End Area	Surf. Area	Volume
a. Plant Mix	26.3 S.F.	44,083.7 S.Y.	5,143.1 C.Y.	26.3 S.F.	44,083.7 S.Y.	5,143.1 C.Y.
b. Top Surf.	18.8 S.F.	44,083.7 S.Y.	3,676.4 C.Y.	18.8 S.F.	44,083.7 S.Y.	3,676.4 C.Y.
c. Base Crse.	71.1 S.F.	46,346.7 S.Y.	13,904.0 C.Y.	118.5 S.F.	46,346.6 S.Y.	23,173.3 C.Y.
d. Prime		44,083.7 S.Y.			44,083.7 S.Y.	
e. Tack		44,083.7 S.Y.			44,083.7 S.Y.	

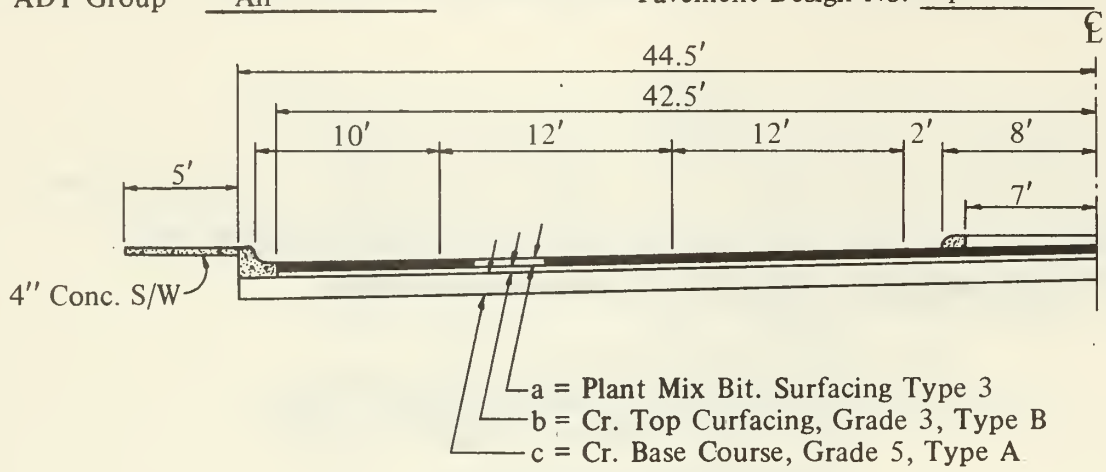
Base & Surfacing Quantities Per Mile

No.	Item	Unit	Cost Area 1 Quantity/Mi.	Cost Area 2 Quantity/Mi.
1	Rolling Surface Courses	Unit	183.0	268.8
2	Water Surface Courses	M. Gal.	813.1	1,241.8
3	Cr. Base Course, Grade 5, Type A	Ton	25,722.4	42,870.6
4	Cr. Top Surfacing, Grade 3, Type B	Ton	6,801.3	6,801.3
5	Plant Mix Bituminous Surfacing, Type 3	Ton	9,913.3	9,913.3
6	Mineral Filler	Ton	99.1	99.1
7	Asphalt Cement 120 - 150	Ton	644.4	644.4
8	Liquid Asphalt MC-70 (Prime)	Ton	56.2	56.2
9	Emulsified Asphalt SS-1 (Tack)	Gal.	4,408.4	4,408.4
10	Median Guard Rail, Concrete Pre-Cast	L.F.	0	0
11	Median Curb	L.F.	0	0
12	Concr. Curb and Gutter	L.F.	9,800.0	9,800.0
13	Sidewalks	Sq. Ft.	4,880.0	4,880.0

MONTANA HIGHWAY FUNCTIONAL CLASSIFICATION & NEEDS STUDY - 1974 UPDATE

Design Std. No.s 40: 4-lane w/16' Median Dwg. No. 14

ADT Group All Pavement Design No. 1



½ Section Shown

Typical Section Dimensions

	Plant Mix		Top Surf.		Base Crse.	
	a	A	b	B	c	C
Cost Area 1	0.35	85	0.25	85	0.90	89
Cost Area 2	0.35	85	0.25	85	1.50	87

Typical Section Quantities Per Mile

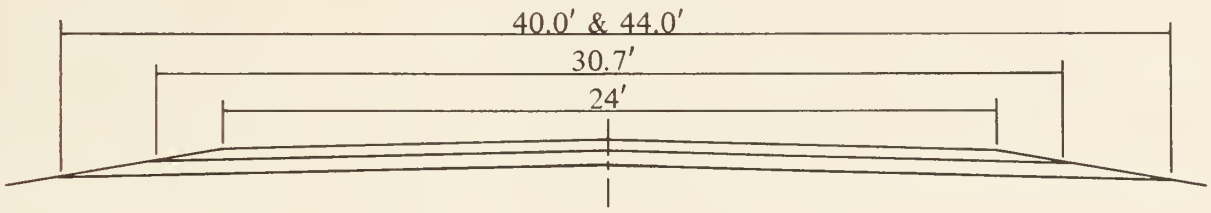
Course	COST AREA 1			COST AREA 2		
	End Area	Surf. Area	Volume	End Area	Surf. Area	Volume
a. Plant Mix	29.8 S.F.	49,950.9 S.Y.	5,827.6 C.Y.	29.8 S.F.	49,950.9 S.Y.	5,827.6 C.Y.
b. Top Surf.	21.3 S.F.	44,950.9 S.Y.	4,165.3 C.Y.	21.3 S.F.	49,950.9 S.Y.	4,165.3 C.Y.
c. Base Crse.	80.1 S.F.	52,213.3 S.Y.	15,664.0 C.Y.	133.5 S.F.	52,213.4 S.Y.	26,106.7 C.Y.
d. Prime		49,950.9 S.Y.			49,950.9 S.Y.	
e. Tack		49,950.9 S.Y.			49,950.9 S.Y.	

Base & Surfacing Quantities Per Mile

No.	Item	Unit	Cost Area 1 Quantity/Mi.	Cost Area 2 Quantity/Mi.
1	Rolling Surface Courses	Unit	206.5	303.1
2	Water Surface Courses	M. Gal.	917.1	1,400.1
3	Cr. Base Course, Grade 5, Type A	Ton	28,978.4	48,297.4
4	Cr. Top Surfacing, Grade 3, Type B	Ton	7,705.8	7,705.8
5	Plant Mix Bituminous Surfacing, Type 3	Ton	11,232.7	11,232.7
6	Mineral Filler	Ton	112.3	112.3
7	Asphalt Cement 120 - 150	Ton	730.1	730.1
8	Liquid Asphalt MC-70 (Prime)	Ton	63.7	63.7
9	Emulsified Asphalt SS-1 (Tack)	Gal.	4,995.1	4,995.1
10	Median Guard Rail, Concrete Pre-Cast	L.F.	0	0
11	Median Curb	L.F.	9,200.0	9,200.0
12	Concr. Curb and Gutter	L.F.	9,800.0	9,800.0
13	Sidewalks	Sq. Ft.	4,880.0	4,880.0

MONTANA HIGHWAY FUNCTIONAL CLASSIFICATION & NEEDS STUDY - 1974 UPDATE

Gravel Section Costs Per Mile
(Gravel Local Roads & Gravel Minor Collectors)



0.50′ Cr. Top Surf.
(0.70′ Select Surf. (Cost Area 1)
(1.00′ Select Surf. (Cost Area 2)

	End Areas: Sq. Ft.		Volumes: C.Y. / Mile		Tons / Mile	
Cost Area→	1	2	1	2	1	2
Top Surf.	13.7	13.7	2,679.1	2,679.1	4,956.3	4,956.3
Select Surf.	24.7	37.3	4,830.2	7,294.2	8,935.9	13,494.3

Costs Per Mile

			COST AREA ONE			COST AREA TWO		
No.	Item		Quant./Mile	Unit Price	Cost/Mile	Quant./Mile	Unit Price	Cost/Mile
1.	Rolling	Units	84.3	14.21	1,197.90	107.1	12.79	1,369.81
2.	Water	M.Gal.	347.3	2.69	934.24	461.3	3.09	1,425.42
3.	Cr. Top Surf.	Ton	4,956.3	2.32	11,498.62	4,956.3	2.33	11,548.18
4	Select Surf.	Ton	8,935.9	1.26	11,259.23	13,494.3	1.20	16,193.16
5.	Binder	C.Y.	144.1	1.42	204.62	144.1	1.38	198.86
6.	Haul Binder	Mi-Yd.	288.2	0.18	51.88	288.2	0.16	46.11
				Sub-total ---	25,146		Sub-total --	30,781
				+ 10% Eng.--	2,515		+ 10% Eng.-	3,078
				Total -----	27,661		Total ----	33,860

APPENDIX B

UNIT AND PER-MILE COSTS

APPENDIX B

I. UNIT AND PER–MILE COSTS

A. Cost Areas

Upon examining the additional cost data used in the 1974 Update, it was found that the same basic relationship still prevailed between costs in the two cost areas that did when they were established for the 1970-1990 Study. As such, the cost areas remained unchanged and are shown in Figure B-1.

B. Five-Year Cost Data Analysis

It was originally planned to base the 1974 Update cost analysis on historical data taken from state projects let during 1971 and 1972. However, it was found upon examining this data, that sufficient projects were not available from these two years to fill the various categories required by the analysis. It was therefore decided that, by applying appropriate annual construction cost indicies to data taken from projects let in the years 1968 through 1972, sufficient projects would be available to develop costs directly for each category required. This also eliminated the need for the complex index system used to fill the required categories in the 1970-1990 Study.

C. Annual Construction Cost Indicies

Individual construction cost indicies were computed for each of the years 1968 through 1972 and for each of the construction classifications: (1) grading, (2) drainage, (3) base and surfacing, and (4) all "other" costs not included in (1) through (3). These indicies were computed using the *Tabulation of Low Bid Prices and Computation of Average Prices* (MDH) for each of the five years according to the following procedure:

(1) The quantities and average unit prices were listed for every construction cost item that appeared exactly the same in each of the five tabulations. (Apparent one-bid items were omitted.)

(2) The total quantity for the five-year period was obtained for each item and divided to produce an average annual quantity.

(3) This average annual quantity for each construction cost item was multiplied by the average unit price per item from each of the five years and the results summed to produce the "total cost" for each year based on the same set of quantities. This was done for each of the construction classifications listed above.

(4) These "total costs" were then tabulated and indexed with 1971 being the base year as follows:

FIGURE NO. B-1

COST AREAS

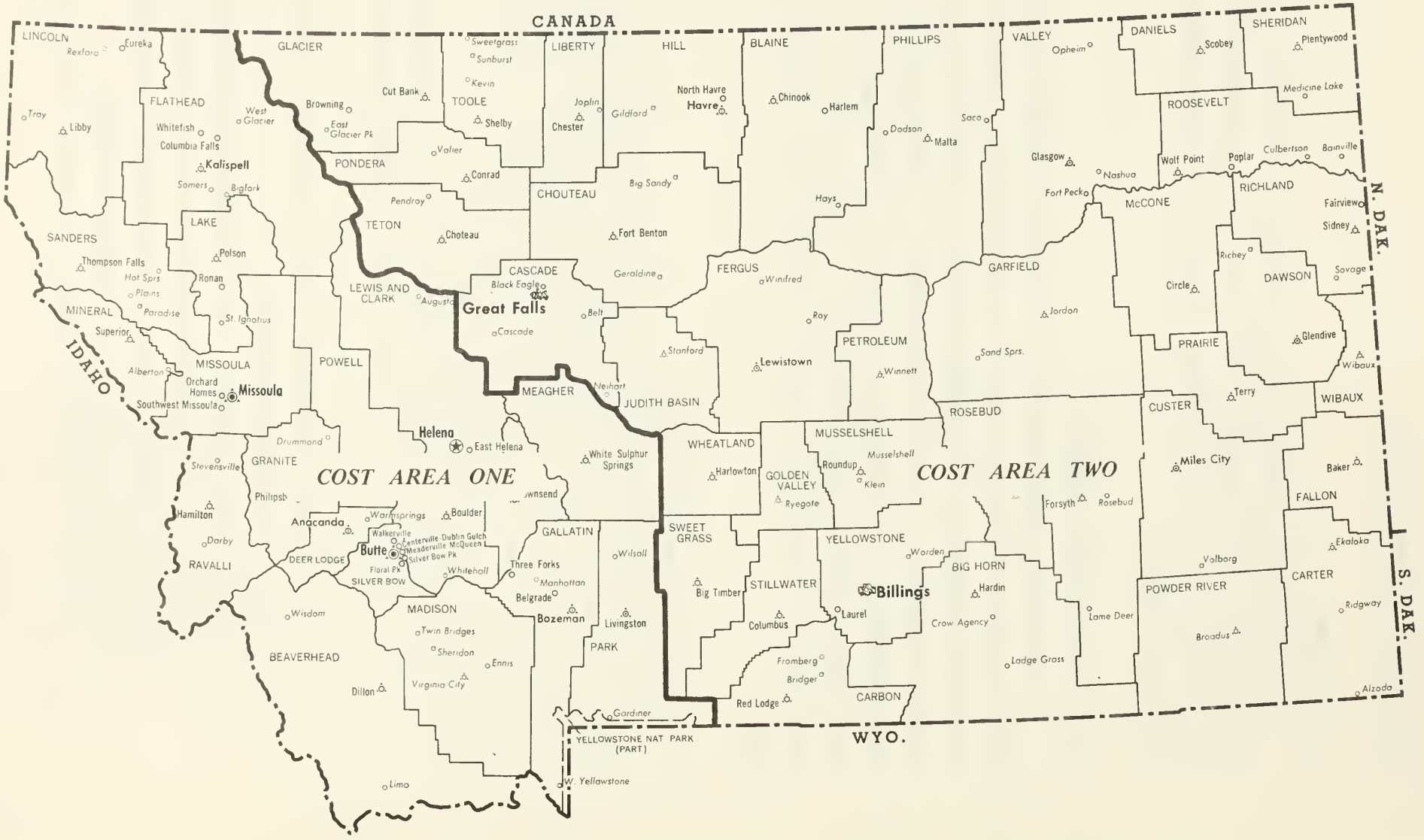


TABLE NO. B-1

ANNUAL CONSTRUCTION COST INDICIES

Construction Classification	1968	1969	1970	1971	1972	
Grading -----	3,844,012	4,476,069	5,901,384	6,103,087	6,235,639	Total Cost
	1.5876	1.3634	1.0341	1.0000	0.9787	Index
Drainage ----	2,776,968	2,978,008	3,151,107	3,367,750	3,481,639	Total Cost
	1.2127	1.1308	1.0687	1.0000	0.9672	Index
Base & Surface –	9,826,998	9,818,463	11,062,959	12,596,648	10,863,100	Total Cost
	1.2818	1.2830	1.1386	1.0000	1.1596	Index
"Other"-----	1,714,342	2,126,448	2,142,862	2,361,453	2,206,872	Total Cost
	1.3774	1.1105	1.1020	1.0000	1.0700	Index
Combined ---	18,162,320	19,398,988	22,258,312	24,428,938	22,787,250	Total Cost
	1.3450	1.2593	1.0975	1.0000	1.0720	Index

The above indicies were used to factor all cost data taken from projects let in years other than 1971 in order that all data used was representative of the cost level of that year. It should be noted that although the needs analysis period was recently extended two years, and owing to the fact that the construction years 1972 and 1973 experienced an unusual drop in construction costs, the 1971 price level is more representative of the new cut-off date of this study. This is especially true because the decreasing price trend is expected to take a rapid turn in the opposite direction.

D. Development of Average Costs Per Mile

(1) Rural Cost Analysis Categories

The five-year historical cost data from all applicable rural projects was divided into the following categories to become the basis for the desired costs per mile:

Cost Areas (previously described)

Federal-Aid Project Classification (F.A.I., F.A.P., F.A.S.)

Terrain Classification (Flat, Rolling, Mountainous)

(2) Urban Cost Analysis Categories

The five-year historical data from urban projects done by the state, plus a number of municipal projects from various cities, were divided into the following categories for use in developing the desired urban cost per mile:

Urbanized Areas (Great Falls, Billings, Missoula)

Small Urban (by population group)

Urban-in-Rural (populations less than 5,000)

(3) "Basic" Costs Per Mile: Grade & Drain, "Other"

Having assembled the historical data into the categories described above, the detail estimates for each project were examined as follows:

(a) All items classified as Grading were summed to determine their cost per mile.

(b) All items classified as Drainage were summed to determine their cost per mile.

Note: Grading and Drainage costs were taken off separately because of their individual construction cost indicies but were then combined into a single cost per mile for Grade and Drain.

(c) All items classified as Base and Surfacing were listed on a separate worksheet for use in the unit price analysis to be explained later.

(d) All items not classified under (a), (b), or (c) were summed to determine their cost per mile.

(e) Because many projects did not include seeding, a separate take-off was made when possible and the resulting cost per mile added to the cost per mile for "Other".

Typical worksheets for the above procedure have been included as Figures B-2 and B-3, and were the same for both rural and urban projects. Having completed worksheets for all projects available, the total cost for all projects in each analysis category (Paragraphs D-1 and D-2) were divided by the corresponding number of total miles to obtain the average cost per mile for each category. These "Basic" costs per mile were then expanded to fit the various design standard numbers. This final procedure is explained later.

(4) Costs Per Mile: Base and Surfacing

Using the Base and Surfacing Project Take-off Sheets (Figure B-3), and working within the analysis categories, average unit prices were computed for each of the items listed on the typical sections (Appendix A). These average unit prices, together with the quantities from the typical sections, produced the desired cost per mile for Base and Surfacing for each required design standard number.

(5) Expanding "Basic" Costs to Design Standard Numbers (DSN's)

The following outline explains how the "Basic" costs per mile from each of the cost analysis categories were correlated to the various design standard numbers.

(a) Cost Areas

All rural costs were developed separately within each of the two cost areas. The only case where cost areas entered into the urban cost analysis was where small urban and urban-in-rural areas were concerned. Further, this distinction could only be made in the costs per mile for Base and Surfacing.

FIGURE NO. B-2

PROJECT TAKE–OFF

Project No._____ _____ Date: _____

Functional Classification _____ Lanes _____ Cost Area _____

Work: _____

Terrain Classification

Total Excav._____CY. Length_____Mi. Exc./Mi._____CY/Mi. Terrain____

Grade & Drain Costs

		Index		1971 Price
(1) Grading & Related				
Total Cost_____				
Length _____Mi.				
Cost/Mi. _____/Mi.	x	_____	=	_____
(2) Drainage & Related				
Total Cost_____				
Length _____Mi.				
Cost/Mi. _____/Mi.	x	_____	=	_____
Total Cost/Mi.: Gr. & Dr.			=	_____

"Other" Costs

(1) General Items				
Total Cost_____				
Length _____Mi.				
Cost/Mi. _____/Mi.	x	_____	=	_____
(2) Fencing				
Total Cost_____				
Length _____Mi.				
Cost/Mi. _____/Mi.	x	_____	=	_____
(3) Signing				
Total Cost_____				
Length _____Mi.				
Cost/Mi. _____/Mi.	x	_____	=	_____
(4) Seeding* _____/Mi.	x	_____	=	_____
Total Cost/Mi.: "Other"			=	_____

Seeding

Total Cost_____

Length _____Mi.

Cost/Mi. _____/Mi.

* Seeding costs have been averaged from typical projects.

FIGURE NO. B-3

BASE & SURFACING PROJECT TAKE–OFF

Project No._____

Cost Area_____ F.A. Classification_____ Terrain_____

Construction Year: 19___ Cost Index_____

Item Bid Prices

Item No.	Item	Unit	Bid Price	Equivalent 1971 Price
1	Rolling Surface Courses	Unit	_____	_____
2	Water Surface Courses	M.Gal.	_____	_____
3	Base Course, Gr. 5, Type A	Ton	_____	_____
4	Top Surfacing, Gr. 3, Type B	Ton	_____	_____
5	Plant Mix Bit. Surfacing, Type 3	Ton	_____	_____
6	Mineral Filler	Ton	_____	_____
7	Asphalt Cement 120-150	Ton	_____	_____
8	Liquid Asphalt MC-70	Ton	_____	_____
9	Emulsified Asphalt SS-1	Ton	_____	_____
10	Median Guard Rail	L.F.	_____	_____

(b) Federal-Aid Project Classifications to DSN's

The manner in which the "Basic" costs correspond to the DSN's may best be seen on the Rural Construction Cost Summaries (Tables B-3 through B-5). Briefly however:

F.A.I. project costs = All 4-lane DSN's.

F.A.P. project costs = All 2-lane Principal Arterials DSN's and all other DSN's where ADT is greater than 700.

F.A.S. project costs = All DSN's where ADT is less than 700 (except for Principal Arterials).

It was not possible to determine any distinction between project classifications where urban costs were concerned. Thus, two "Basic" costs per mile (2-lane and 4-lane) were developed to apply to all urban DSN's. However, these costs were classified according to urban areas.

(c) Terrain Classification to DSN's

The question here is self-explanatory since each terrain classification carries its own DSN and they do not apply to urban DSN's.

(d) Procedures: Grade & Drain and "Other"

1. F.A.I. to DSN

The costs developed from rural F.A.I. projects in each cost area and terrain classification were applied directly to the corresponding 4-lane DSN's.

2. F.A.P. to DSN

The Grade and Drain costs developed from rural F.A.P. projects were divided by 36, the average roadway width of the projects used to develop the "Basic" costs per mile, and multiplied by the roadway width of each applicable DSN. The "Basic" costs developed for "Other" were applied directly with no distinction made for roadway width.

3. F.A.S. to DSN

The Grade and Drain costs developed from rural F.A.S. projects were divided by 28, the average roadway width of projects used to develop the costs, and multiplied by the roadway width of each applicable DSN. As above, the "Other" costs were applied without distinction for roadway width.

4. Urban Costs to DSN

The 2-lane urban costs were applied directly from the "Basic" cost per mile. The 4-lane costs were prorated from the "Basic" cost per mile according to the DSN template width.

E. **Type of Improvement**

The costs per mile developed for each DSN according to foregoing procedures were considered representative of the type of improvement classified as reconstruction. It then remained to expand these costs to represent the other improvement classifications as follows:

(1) **New Location**

The costs for new location were estimated from the reconstruction costs per mile according to the following schedule:

(a) **Rural Grade & Drain and "Other"**

Flat ——————— New Location Cost = Reconstruction Cost x 1.1

Rolling ————— New Location Cost = Reconstruction Cost x 1.2

Mountainous —— New Location Cost = Reconstruction Cost x 1.3

(b) **Urban Grade & Drain**

New Location Grading = Reconstruction Grading

New Location Drainage = 1.5 x Reconstruction Drainage

(c) **Urban "Other"**

New Location "Other" = 1.1 x Reconstruction "Other"

The factors shown in the above schedule were derived by examining the amount of additional grading associated with reconstruction, the amount and cost of relocating salvable material, and the cost items which occur regardless of type of improvement.

(d) **Urban and Rural Base and Surfacing**

In all cases, the cost for base and surfacing was equal for both types of improvement.

(2) **Widening**

The costs for widening were computed in terms of W, the amount of widening required (as determined by the Needs Analysis), as follows:

(a) **Rural and Urban Grade & Drain**

Computed as a "W" multiplier equal to the cost/foot/mile from the reconstruction costs.

(b) **Rural and Urban Base & Surfacing**

Computed from the actual quantities required to provide a complete new riding surface plus sub-base under the widened portion only.

(c) **Rural and Urban "Other"**

It was assumed that all "Other" items associated with reconstruction would be equally applicable for widening projects. As such, the "Other" are equal for both types of improvements.

(3) Resurfacing

The costs for resurfacing were based on the quantities required to provide a 0.25′ overlay on existing roadways over 30 feet wide and a 0.20′ overlay on those under 30 feet.

F. Right-of-Way Costs Per Mile

The costs per mile for right-of-way acquisition and its related costs were computed using two factors: (1) the estimated unit cost for land including the costs associated with its acquisition, and (2) the amount of right-of-way required for each type of improvement. The first, costs, were provided by the Right-of-Way Division, MDH. The second, the required "take", was estimated according to the following schedule:

TABLE NO. B-2

RURAL RIGHT–OF–WAY "TAKE"

Project Classification	Type of Improvement	Desirable R/W	Average Existing R/W	Estimated "Take" Per Mile
F.A.I.	New Location	288 Ft.	0	34.91 Acres
	Reconstruction	288 Ft.	130 Ft.	19.15 Acres
F.A.P.	New Location	160 Ft.	0	19.39 Acres
	Reconstruction	160 Ft.	100 Ft.	7.27 Acres
F.A.S.	New Location	130 Ft.	0	15.76 Acres
	Reconstruction	130 Ft.	60 Ft.	8.48 Acres

The desirable right-of-way shown above is based on slope and recovery area recommendations made in the 1967 AASHO *Yellow Book*. To allow for construction limits outside the above corridors, the following factors were applied for rolling and mountainous terrain:

Rolling Terrain $f = 1.070$

Mountainous Terrain $f = 1.150$

Widening and resurfacing improvements on rural sections were considered to require no additional right-of-way.

It was decided that all improvements in urban areas could (or might have to be) made on the existing right-of-way, except for new locations. It was also decided, however, that all improvements except resurfacing should include some cost for utility adjustments. These costs were found to be as variable as the number of projects examined. By eliminating all extreme cases, however, it was found that utility costs varied from 10 to 15 percent of the grading and drainage costs. Therefore, for urban reconstruction and widening improvements, 12 percent of the grade and drain costs were added under right-of-way. Right-of-way costs for urban new loca-

tion improvements were computed directly from the "take" and unit cost figures supplied by the state.

G. Structure Costs

A current schedule of estimated costs per square foot for various type structures was provided by the Bridge Section, MDH. These were applied to derive the estimated costs for needed structure improvements in the following manner:

Structures up to 400′ = $22.00 per S.F.

Structures 400′ to 800′ = $30.00 per S.F.

Structures over 800′ = $35.00 per S.F.

H. Summary

The foregoing procedures were developed and applied with a single purpose in mind; that being to compile a schedule of *average* costs per mile to be applied to the improvements determined as necessary by the needs analysis. In a study such as this, it is imperative that estimating costs be as closely representative of the actual costs *in the majority of the cases to which they are applied*. The accumulation and classification of the available historical data and its expansion to a form consistent with the needs analysis has been intended to accomplish this end. The resulting schedules of costs per mile are given in the following summaries.

TABLE NO. B-3

RURAL CONSTRUCTION COST SUMMARY NO. 1

Cost Area One

DESCRIPTION						NEW LOCATION				RECONSTRUCTION				RESURFACING			
Functional Classification	Design Year ADT Group	D.S.N.	Lanes	Terrain	Proj. Equiv.	Grade & Drain	Surfacing	Other	Total	Grade & Drain	Surfacing	Other	Total	Grade & Drain	Surfacing	Other	Total
Principal Arterials	All	1	2	F	F.A.P.	113,131	117,282	25,743	256,156	102,848	117,282	23,402	243,532	1,895	47,375	2,843	52,113
		1	4	F	F.A.I.	242,408	173,035	43,900	459,343	220,371	173,035	39,909	433,315	3,296	82,402	4,944	90,642
		2	2	R	F.A.P.	218,185	117,282	34,300	369,767	181,820	117,282	28,583	327,685	1,895	47,375	2,843	52,113
		2	4	R	F.A.I.	462,737	173,035	50,483	686,255	385,615	173,035	42,070	600,720	3,296	82,402	4,944	90,642
		3	2	M	F.A.P.	295,664	117,282	52,353	465,299	227,435	117,282	40,272	384,989	1,895	47,375	2,843	52,113
		3	4	M	F.A.I.	681,523	210,034	76,552	968,109	524,248	210,034	58,886	793,168	3,459	86,473	5,188	95,120
Minor Arterials	0-100	4	2	F	F.A.S.	64,956	49,629	18,533	133,118	59,051	49,629	16,849	125,529	961	24,026	1,442	26,429
		5	2	R	F.A.S.	130,229	49,629	22,969	202,827	108,524	49,629	19,141	177,294	961	24,026	1,442	26,429
		6	2	M	F.A.S.	192,864	49,629	35,867	278,360	148,356	49,629	27,590	225,575	961	24,026	1,442	26,429
	100-450	7	2	F	F.A.S.	64,956	56,112	18,533	139,601	59,051	56,112	16,849	132,012	961	24,026	1,442	26,429
		8	2	R	F.A.S.	130,229	56,112	22,969	209,310	108,524	56,112	19,141	183,777	961	24,026	1,442	26,429
		9	2	M	F.A.S.	192,864	56,112	35,867	284,843	148,356	56,112	27,590	232,058	961	24,026	1,442	26,429
	450-700	10	2	F	F.A.S.	69,596	61,131	18,533	149,260	63,269	61,131	16,849	141,249	1,027	25,680	1,541	28,248
		11	2	R	F.A.S.	139,531	61,131	22,969	223,631	116,276	61,131	19,141	196,548	1,027	25,680	1,541	28,248
		12	2	M	F.A.S.	192,864	57,668	35,867	286,399	148,356	57,668	27,590	233,614	961	24,026	1,442	26,429
	700-1400	13	2	F	F.A.P.	92,562	80,429	25,743	198,734	84,148	80,429	23,402	187,979	1,566	39,145	2,349	43,060
		14	2	R	F.A.P.	168,598	76,576	34,300	279,474	140,497	76,576	28,583	245,656	1,483	37,084	2,225	40,792
		15	2	M	F.A.P.	228,468	76,576	52,353	357,397	175,745	76,576	40,272	292,593	1,483	37,084	2,225	40,792
	1400-2800	16	2	F	F.A.P.	102,847	97,647	25,743	226,237	93,498	97,647	23,402	214,547	1,730	43,260	2,596	47,586
		17	2	R	F.A.P.	198,350	97,647	34,300	330,297	165,291	97,647	28,583	291,521	1,730	43,260	2,596	47,586
		18	2	M	F.A.P.	268,786	97,647	52,353	418,786	206,759	97,647	40,272	344,678	1,730	43,260	2,596	47,586
	2800+	19	2	F	F.A.P.	113,131	117,282	25,743	256,156	102,848	117,282	23,402	243,532	1,895	47,375	2,843	52,113
		19	4	F	F.A.I.	242,408	173,035	43,900	459,343	220,371	173,035	39,909	433,315	3,296	82,402	4,944	90,642
		20	2	R	F.A.P.	218,185	117,282	34,300	369,767	181,820	117,282	28,583	327,685	1,895	47,375	2,843	52,113
		20	4	R	F.A.I.	462,737	173,035	50,483	686,255	385,615	173,035	42,070	600,720	3,296	82,402	4,944	90,642
		21	2	M	F.A.P.	295,664	117,282	52,353	465,299	227,435	117,282	40,272	384,989	1,895	47,375	2,843	52,113
		21	4	M	F.A.I.	681,523	210,034	76,552	968,109	524,248	210,034	58,886	793,168	3,459	86,473	5,188	95,120
Collectors	0-100	22	2	F	F.A.S.	60,317	46,492	18,533	125,342	54,833	46,492	16,849	118,174	895	22,370	1,342	24,607
		23	2	R	F.A.S.	120,927	46,492	22,969	190,388	100,773	46,492	19,141	166,406	895	22,370	1,342	24,607
		24	2	M	F.A.S.	179,088	46,492	35,867	261,447	137,759	46,492	27,590	211,841	895	22,370	1,342	24,607
	100-450	25	2	F	F.A.S.	64,956	56,112	18,533	139,601	59,051	56,112	16,849	132,012	961	24,026	1,442	26,429
		26	2	R	F.A.S.	130,229	56,112	22,969	209,310	108,524	56,112	19,141	183,777	961	24,026	1,442	26,429
		27	2	M	F.A.S.	192,864	56,112	35,867	284,843	148,356	56,112	27,590	232,058	961	24,026	1,442	26,429
	450-700	28	2	F	F.A.S.	69,596	61,131	18,533	149,260	63,269	61,131	16,849	141,249	1,027	25,680	1,541	28,248
		29	2	R	F.A.S.	139,531	61,131	22,969	223,631	116,276	61,131	19,141	196,548	1,027	25,680	1,541	28,248
		30	2	M	F.A.S.	192,864	57,668	35,867	286,399	148,356	57,668	27,590	233,614	961	24,026	1,442	26,429
	700-1400	31	2	F	F.A.P.	92,562	80,429	25,743	198,734	84,148	80,429	23,402	187,979	1,566	39,145	2,349	43,060
		32	2	R	F.A.P.	168,598	76,576	34,300	279,474	140,497	76,576	28,583	245,656	1,483	37,084	2,225	40,792
		33	2	M	F.A.P.	228,468	76,576	52,353	357,397	175,745	76,576	40,272	292,593	1,483	37,084	2,225	40,792
	1400-2800	34	2	F	F.A.P.	102,847	97,647	25,743	226,237	93,498	97,647	23,402	214,547	1,730	43,260	2,596	47,586
		35	2	R	F.A.P.	198,350	97,647	34,300	330,297	165,291	97,647	28,583	291,521	1,730	43,260	2,596	47,586
		36	2	M	F.A.P.	268,786	97,647	52,353	418,786	206,759	97,647	40,272	344,678	1,730	43,260	2,596	47,586
	2800+	37	2	F	F.A.P.	113,131	117,282	25,743	256,156	102,848	117,282	23,402	243,532	1,895	47,375	2,843	52,113
		38	2	R	F.A.P.	218,185	117,282	34,300	369,767	181,820	117,282	28,583	327,685	1,895	47,375	2,843	52,113
		39	2	M	F.A.P.	295,664	117,282	52,353	465,299	227,435	117,282	40,272	384,989	1,895	47,375	2,843	52,113

TABLE NO. B-4

RURAL CONSTRUCTION COST SUMMARY NO. 1

Cost Area Two

DESCRIPTION						NEW LOCATION				RECONSTRUCTION				RESURFACING			
Functional Classification	Design Year ADT Group	D.S.N.	Lanes	Terrain	Proj. Equiv.	Grade & Drain	Surfacing	Other	Total	Grade & Drain	Surfacing	Other	Total	Grade & Drain	Surfacing	Other	Total
Principal Arterials	All	1	2	F	F.A.P.	112,675	137,011	22,870	272,556	102,432	137,011	20,790	260,233	1,844	46,101	2,766	50,711
		1	4	F	F.A.I.	180,073	193,279	31,571	404,923	163,703	193,279	28,701	385,683	3,207	80,183	4,811	88,201
		2	2	R	F.A.P.	147,598	137,011	31,593	316,202	122,997	137,011	26,328	286,336	1,844	46,101	2,766	50,711
		2	4	R	F.A.I.	336,266	193,279	39,830	569,375	280,222	193,279	33,192	506,693	3,207	80,183	4,811	88,201
		3	2	M	F.A.P.	184,563	137,011	51,500	373,074	141,971	137,011	39,616	318,598	1,844	46,101	2,766	50,711
		3	4	M	F.A.I.	568,663	226,133	64,671	859,467	437,433	226,133	49,746	713,312	3,366	84,154	5,049	92,569
Minor Arterials	0-100	4	2	F	F.A.S.	46,113	56,341	12,685	115,139	41,922	56,341	11,531	109,794	934	23,353	1,401	25,688
		5	2	R	F.A.S.	68,384	56,341	16,679	141,404	56,987	56,341	13,899	127,227	934	23,353	1,401	25,688
		6	2	M	F.A.S.	85,452	56,341	28,022	169,815	65,732	56,341	21,556	143,629	934	23,353	1,401	25,688
	100-450	7	2	F	F.A.S.	46,113	63,025	12,685	121,823	41,922	63,025	11,531	116,478	934	23,353	1,401	25,688
		8	2	R	F.A.S.	68,384	63,025	16,679	148,088	56,987	63,025	13,899	133,911	934	23,353	1,401	25,688
		9	2	M	F.A.S.	85,452	63,025	28,022	176,499	65,732	63,025	21,556	150,313	934	23,353	1,401	25,688
	450-700	10	2	F	F.A.S.	49,407	73,855	12,685	135,947	44,916	73,855	11,531	130,302	998	24,961	1,498	27,457
		11	2	R	F.A.S.	73,269	73,855	16,679	163,803	61,058	73,855	13,899	148,812	998	24,961	1,498	27,457
		12	2	M	F.A.S.	85,452	69,882	28,022	183,356	65,732	69,882	21,556	157,170	934	23,353	1,401	25,688
	700-1400	13	2	F	F.A.P.	92,189	99,768	22,870	214,827	83,808	99,768	20,790	204,366	1,524	38,090	2,285	41,899
		14	2	R	F.A.P.	114,053	95,189	31,593	240,835	95,043	95,189	26,328	216,560	1,443	36,085	2,165	39,693
		15	2	M	F.A.P.	142,617	95,189	51,500	289,306	109,705	95,189	39,616	244,510	1,443	36,085	2,165	39,693
	1400-2800	16	2	F	F.A.P.	102,432	115,869	22,870	241,171	93,120	115,869	20,790	229,779	1,684	42,096	2,526	46,306
		17	2	R	F.A.P.	134,180	115,869	31,593	281,642	111,816	115,869	26,328	254,013	1,684	42,096	2,526	46,306
		18	2	M	F.A.P.	167,784	115,869	51,500	335,153	129,064	115,869	39,616	284,549	1,684	42,096	2,526	46,306
	2800+	19	2	F	F.A.P.	112,675	137,011	22,870	272,556	102,432	137,011	20,790	260,233	1,844	46,101	2,766	50,711
		19	4	F	F.A.I.	180,073	193,279	31,571	404,923	163,703	193,279	28,701	385,683	3,207	80,183	4,811	88,201
		20	2	R	F.A.P.	147,598	137,011	31,593	316,202	122,997	137,011	26,328	286,336	1,844	46,101	2,766	50,711
		20	4	R	F.A.I.	336,266	193,279	39,830	569,375	280,222	193,279	33,192	506,693	3,207	80,183	4,811	88,201
		21	2	M	F.A.P.	184,563	137,011	51,500	373,074	141,971	137,011	39,616	318,598	1,844	46,101	2,766	50,711
		21	4	M	F.A.I.	568,663	226,133	64,671	859,467	437,433	226,133	49,746	713,312	3,366	84,154	5,049	92,569
Collectors	0-100	22	2	F	F.A.S.	42,819	53,031	12,685	108,535	38,927	53,031	11,531	103,489	870	21,744	1,305	23,919
		23	2	R	F.A.S.	63,500	53,031	16,679	133,210	52,917	53,031	13,899	119,847	870	21,744	1,305	23,919
		24	2	M	F.A.S.	79,349	53,031	28,022	160,402	61,037	53,031	21,556	135,624	870	21,744	1,305	23,919
	100-450	25	2	F	F.A.S.	46,113	63,025	12,685	121,823	41,922	63,025	11,531	116,478	934	23,353	1,401	25,688
		26	2	R	F.A.S.	68,384	63,025	16,679	148,088	56,987	63,025	13,899	133,911	934	23,353	1,401	25,688
		27	2	M	F.A.S.	85,452	63,025	28,022	176,499	65,732	63,025	21,556	150,313	934	23,353	1,401	25,688
	450-700	28	2	F	F.A.S.	49,407	73,855	12,685	135,947	44,916	73,855	11,531	130,302	998	24,961	1,498	27,457
		29	2	R	F.A.S.	73,269	73,855	16,679	163,803	61,058	73,855	13,899	148,812	998	24,961	1,498	27,457
		30	2	M	F.A.S.	85,452	69,882	28,022	183,356	65,732	69,882	21,556	157,170	934	23,353	1,401	25,688
	700-1400	31	2	F	F.A.P.	92,189	99,768	22,870	214,827	83,808	99,768	20,790	204,366	1,524	38,090	2,285	41,899
		32	2	R	F.A.P.	114,053	95,189	31,593	240,835	95,043	95,189	26,328	216,560	1,443	36,085	2,165	39,693
		33	2	M	F.A.P.	142,617	95,189	51,500	289,306	109,705	95,189	39,616	244,510	1,443	36,085	2,165	39,693
	1400-2800	34	2	F	F.A.P.	102,432	115,869	22,870	241,171	93,120	115,869	20,790	229,779	1,684	42,096	2,526	46,306
		35	2	R	F.A.P.	134,180	115,869	31,593	281,642	111,816	115,869	26,328	254,013	1,684	42,096	2,526	46,306
		36	2	M	F.A.P.	167,784	115,869	51,500	335,153	129,064	115,869	39,616	284,549	1,684	42,096	2,526	46,306
	2800+	37	2	F	F.A.P.	112,675	137,011	22,870	272,556	102,432	137,011	20,790	260,233	1,844	46,101	2,766	50,711
		38	2	R	F.A.P.	147,598	137,011	31,593	316,202	122,997	137,011	26,328	286,336	1,844	46,101	2,766	50,711
		39	2	M	F.A.P.	184,563	137,011	51,500	373,074	141,971	137,011	39,616	318,598	1,844	46,101	2,766	50,711

TABLE NO. B-5

RURAL CONSTRUCTION COST SUMMARY NO. 2

WIDENING

DESCRIPTION						COST AREA ONE			COST AREA TWO		
Functional Classification	Design Year ADT Group	D.S.N.	Lanes	Terrain	Proj. Equiv.	Grade & Drain	Surfacing	Other	Grade & Drain	Surfacing	Other
Principal Arterials	All	1	2	F	F.A.P.	2,337 W		23,402	2,328 W		20,790
		2	2	R	F.A.P.	4,132 W	46,960 + 1,027 W	28,583	2,795 W	45,698 + 1,297 W	26,328
		3	2	M	F.A.P.	5,169 W		40,272	3,227 W		39,616
Minor Arterials	0-100	4	2	F	F.A.S.	2,109 W		16,849	1,497 W		11,531
		5	2	R	F.A.S.	3,876 W	24,439 + 753 W	19,141	2,035 W	23,761 + 912 W	13,899
		6	2	M	F.A.S.	5,298 W		27,590	2,348 W		21,556
	100-450	7	2	F	F.A.S.	2,109 W		16,849	1,497 W		11,531
		8	2	R	F.A.S.	3,876 W	24,448 + 876 W	19,141	2,035 W	23,759 + 1,060 W	13,899
		9	2	M	F.A.S.	5,298 W		27,590	2,348 W		21,556
	450-700	10	2	F	F.A.S.	2,109 W	26,101 + 917 W	16,849	1,497 W	25,368 + 1,060 W	11,531
		11	2	R	F.A.S.	3,876 W	26,101 + 917 W	19,141	2,035 W	25,368 + 1,060 W	13,899
		12	2	M	F.A.S.	5,298 W	24,446 + 917 W	27,590	2,348 W	23,759 + 1,060 W	21,556
	700-1400	13	2	F	F.A.P.	2,337 W	38,727 + 999 W	23,402	2,328 W	37,681 + 1,149 W	20,790
		14	2	R	F.A.P.	4,132 W	36,666 + 999 W	28,583	2,795 W	35,675 + 1,149 W	26,328
		15	2	M	F.A.P.	5,169 W	36,666 + 999 W	40,272	3,227 W	35,675 + 1,149 W	39,616
	1400-2800	16	2	F	F.A.P.	2,337 W		23,402	2,328 W		20,790
		17	2	R	F.A.P.	4,132 W	42,844 + 1,027 W	28,583	2,795 W	41,688 + 1,260 W	26,328
		18	2	M	F.A.P.	5,169 W		40,272	3,227 W		39,616
	2800+	19	2	F	F.A.P.	2,337 W		23,402	2,328 W		20,790
		20	2	R	F.A.P.	4,132 W	46,960 + 1,027 W	28,583	2,795 W	45,698 + 1,297 W	26,328
		21	2	M	F.A.P.	5,169 W		40,272	3,227 W		39,616
Collectors	0-100	22	2	F	F.A.S.	2,109 W		16,849	1,497 W		11,531
		23	2	R	F.A.S.	3,876 W	22,785 + 753 W	19,141	2,035 W	22,152 + 912 W	13,899
		24	2	M	F.A.S.	5,298 W		27,590	2,348 W		21,556
	100-450	25	2	F	F.A.S.	2,109 W		16,849	1,497 W		11,531
		26	2	R	F.A.S.	3,876 W	24,448 + 876 W	19,141	2,035 W	23,759 + 1,060 W	13,899
		27	2	M	F.A.S.	5,298 W		27,590	2,348 W		21,556
	450-700	28	2	F	F.A.S.	2,109 W	26,101 + 917 W	16,849	1,497 W	25,368 + 1,060 W	11,531
		29	2	R	F.A.S.	3,876 W	26,101 + 917 W	19,141	2,035 W	25,368 + 1,060 W	13,899
		30	2	M	F.A.S.	5,298 W	24,446 + 917 W	27,590	2,348 W	23,759 + 1,060 W	21,556
	700-1400	31	2	F	F.A.P.	2,337 W	38,727 + 999 W	23,402	2,328 W	37,681 + 1,149 W	20,790
		32	2	R	F.A.P.	4,132 W	36,666 + 999 W	28,583	2,795 W	35,675 + 1,149 W	26,328
		33	2	M	F.A.P.	5,169 W	36,666 + 999 W	40,272	3,227 W	35,675 + 1,149 W	39,616
	1400-2800	34	2	F	F.A.P.	2,337 W		23,402	2,328 W		20,790
		35	2	R	F.A.P.	4,132 W	42,844 + 1,027 W	28,583	2,795 W	41,688 + 1,260 W	26,328
		36	2	M	F.A.P.	5,169 W		40,272	3,227 W		39,616
	2800+	37	2	F	F.A.P.	2,337 W		23,402	2,328 W		20,790
		38	2	R	F.A.P.	4,132 W	46,960 + 1,027 W	28,583	2,795 W	45,698 + 1,297 W	26,328
		39	2	M	F.A.P.	5,169 W		40,272	3,227 W		39,616

TABLE NO. B-6

RURAL RIGHT–OF–WAY COST SUMMARY

IMPROVEMENT: Reconstruction & Widening

DEVELOPMENT: Rural

Functional Classification	D.S.N.	Lanes	Terr.	Take	Full Access Control		Partial Access Control		No Access Control	
				Acres/Mile	Cost/Acre	Cost/Mile	Cost/Acre	Cost/Mile	Cost/Acre	Cost/Mile
Principal Arterials	1	2	F	7.27	1,450	10,452	1,250	9,088	1,000	7,270
	1	4	F	19.15	1,450	27,768	1,250	23,938	1,000	19,150
	2	2	R	8.63	1,250	10,788	1,050	9,062	900	7,767
	2	4	R	21.59	1,250	26,988	1,050	22,670	900	19,431
	3	2	M	10.18	900	9,162	750	7,635	650	6,617
	3	4	M	15.27	900	13,743	750	11,453	650	9,926
Minor Arterials	4,7,10	2	F	8.49	1,200	10,188	1,000	8,490	850	7,217
	5,8,11	2	R	9.59	1,050	10,070	900	8,631	750	7,193
	6,9,12	2	M	10.85	900	9,765	750	8,138	650	7,053
	13,16	2	F	7.27	1,200	8,724	1,000	7,270	850	6,180
	14,17	2	R	8.63	1,050	9.062	900	7,767	750	6,473
	15,18	2	M	10.18	900	9,162	750	7,635	650	6,617
	19	2	F	7.27	1,200	8,724	1,000	7,270	850	6,180
	19	4	F	19.15	1,200	22,980	1,000	19,150	850	16,278
	20	2	R	8.63	1,050	9,062	900	7,767	750	6,473
	20	4	R	21.59	1,050	22,670	900	19,431	750	16,193
	21	2	M	10.18	900	9,162	750	7,635	650	6,617
	21	4	M	15.27	900	13,743	750	11,453	650	9,926
Collectors	22,25,28	2	F	8.49					500	4,245
	23,26,29	2	R	9.59					400	3,836
	24,27,30	2	M	10.85					250	2,714
	31,34,37	2	F	7.27					500	3,635
	32,35,38	2	R	8.63					400	3,452
	33,36,39	2	M	10.18					250	2,545

TABLE NO. B-7

RURAL RIGHT–OF–WAY COST SUMMARY

IMPROVEMENT: New Location

DEVELOPMENT: Rural

Functional Classification	D.S.N.	Lanes	Terr.	Take	Full Access Control		Partial Access Control		No Access Control	
				Acres/Mile	Cost/Acre	Cost/Mile	Cost/Acre	Cost/Mile	Cost/Acre	Cost/Mile
Principal Arterials	1	2	F	19.39	1,300	25,207	1,100	21,329	900	17,451
	1	4	F	34.91	1,300	45,383	1,100	38,401	900	31,419
	2	2	R	20.75	1,100	22,825	950	19,713	750	15,563
	2	4	R	37.35	1,100	41,085	950	35,483	750	28,013
	3	2	M	22.30	800	17,840	700	15,610	550	12,265
	3	4	M	31.03	800	24,824	700	21,721	550	17,067
Minor Arterials	4,7,10	2	F	15.76	1,050	16,548	900	14,184	800	12,608
	5,8,11	2	R	16.86	900	15,174	800	13,488	700	11,802
	6,9,12	2	M	18.12	800	14,496	700	12,684	550	9,966
	13,16	2	F	19.39	1,050	20,360	900	17,451	800	15,512
	14,17	2	R	20.75	900	18,675	800	16,600	700	14,525
	15,18	2	M	22.30	800	17,840	700	15,610	550	12,265
	19	2	F	19.39	1,050	20,360	900	17,451	800	15,512
	19	4	F	34.91	1,050	36,656	900	31,419	800	27,928
	20	2	R	20.75	900	18,675	800	16,600	700	14,525
	20	4	R	37.35	900	33,615	800	29,880	700	26,145
	21	2	M	22.30	800	17,840	700	15,610	550	12,265
	21	4	M	31.03	800	24,824	700	21,721	550	17,067
Collectors	22,25,28	2	F	15.76					800	12,608
	23,26,29	2	R	16.86					650	10,959
	24,27,30	2	M	18.12					500	9,060
	31,34,37	2	F	19.39					800	15,512
	32,35,38	2	R	20.75					650	13,488
	33,36,39	2	M	22.30					500	11,150

TABLE NO. B-8

RURAL RIGHT–OF–WAY COST SUMMARY

IMPROVEMENT: New Location

DEVELOPMENT: Dense

Functional Classification	D.S.N.	Lanes	Terr.	Take	Full Access Control		Partial Access Control		No Access Control	
				Acres/Mile	Cost/Acre	Cost/Mile	Cost/Acre	Cost/Mile	Cost/Acre	Cost/Mile
Principal Arterials	1	2	F	7.27	2,800	20,356	2,400	17,448	1,950	14,177
	1	4	F	12.12	2,800	33,936	2,400	29,088	1,950	23,634
	2	2	R	7.27	2,400	17,448	2,050	14,904	1,700	12,359
	2	4	R	12.12	2,400	29,088	2,050	24,846	1,700	20,604
	3	2	M	7.27	1,800	13,086	1,550	11,269	1,250	9,088
	3	4	M	12.12	1,800	21,816	1,550	18,786	1,250	15,150
Minor Arterials	4,7,10	2	F	7.27	2,800	20,356	2,400	17,448	1,950	14,177
	5,8,11	2	R	7.27	2,400	17,448	2,050	14,904	1,700	12,359
	6,9,12	2	M	7.27	1,800	13,086	1,550	11,269	1,250	9,088
	13,16	2	F	7.27	2,800	20,356	2,400	17,448	1,950	14,177
	14,17	2	R	7.27	2,400	17,448	2,050	14,904	1,700	12,359
	15,18	2	M	7.27	1,800	13,086	1,550	11,269	1,250	9,088
	19	2	F	7.27	2,800	20,356	2,400	17,448	1,950	14,177
	19	4	F	12.12	2,800	33,936	2,400	29,088	1,950	23,634
	20	2	R	7.27	2,400	17,448	1,050	14,904	1,700	12,359
	20	4	R	12.12	2,400	29,088	2,050	24,846	1,700	20,604
	21	2	M	7.27	1,800	13,086	1,550	11,269	1,250	9,088
	21	4	M	12.12	1,800	21,816	1,550	18,786	1,250	15,150
Collectors	22,25,28	2	F	7.27					1,700	12,359
	23,26,29	2	R	7.27					1,400	10,178
	24,27,30	2	M	7.27					1,100	7,997
	31,34,37	2	F	7.27					1,700	12,359
	32,35,38	2	R	7.27					1,400	10,178
	33,36,39	2	M	7.27					1,100	7,997

TABLE NO. B-9

RURAL RIGHT–OF–WAY COST SUMMARY

IMPROVEMENT: Reconstruction & Widening

DEVELOPMENT: Dense

Functional Classification	D.S.N.	Lanes	Terr.	Take	Full Access Control		Partial Access Control		No Access Control	
				Acres/Mile	Cost/Acre	Cost/Mile	Cost/Acre	Cost/Mile	Cost/Acre	Cost/Mile
Principal Arterials	1	2	F	W (.1212)	3,500	424 W	3,000	364 W	2,450	297 W
	1	4	F	W (.1212)	3,500	424 W	3,000	364 W	2,450	297 W
	2	2	R	W (.1212)	3,100	376 W	2,650	321 W	2,150	261 W
	2	4	R	W (.1212)	3,100	376 W	2,650	321 W	2,150	261 W
	3	2	M	W (.1212)	2,500	303 W	2,150	261 W	1,750	212 W
	3	4	M	W (.1212)	2,500	303 W	2,150	261 W	1,750	212 W
Minor Arterials	4,7,10	2	F	W (.1212)	3,500	424 W	3,000	364 W	2,450	297 W
	5,8,11	2	R	W (.1212)	3,100	376 W	2,650	321 W	2,150	261 W
	6,9,12	2	M	W (.1212)	2,500	303 W	2,150	261 W	1,750	212 W
	13,16	2	F	W (.1212)	3,500	424 W	3,000	364 W	2,450	297 W
	14,17	2	R	W (.1212)	3,100	376 W	2,650	321 W	2,150	261 W
	15,18	2	M	W (.1212)	2,500	303 W	2,150	261 W	1,750	212 W
	19	2	F	W (.1212)	3,500	424 W	3,000	364 W	2,450	297 W
	19	4	F	W (.1212)	3,500	424 W	3,000	364 W	2,450	297 W
	20	2	R	W (.1212)	3,100	376 W	2,650	321 W	2,150	261 W
	20	4	R	W (.1212)	3,100	376 W	2,650	321 W	2,150	261 W
	21	2	M	W (.1212)	2,500	303 W	2,150	261 W	1,750	212 W
	21	4	M	W (.1212)	2,500	303 W	2,150	261 W	1,750	212 W
Collectors	22,25,28	2	F	W (.1212)					1,100	133 W
	23,26,29	2	R	W (.1212)					1,100	133 W
	24,27,30	2	M	W (.1212)					1,100	133 W
	31,34,37	2	F	W (.1212)					1,100	133 W
	32,35,38	2	R	W (.1212)					1,100	133 W
	33,36,39	2	M	W (.1212)					1,100	133 W

W = Additional right-of-way required.

TABLE NO. B-10

URBAN COST SUMMARY NO. 1

URBAN CONSTRUCTION COSTS: Grade & Drain, "Other"

Urban Area Classification	D.S.N.	Lanes	Median	NEW LOCATION		RECONSTRUCTION	
				Grade & Drain	"Other"	Grade & Drain	"Other"
Urbanized	40,41,42	2	0	302,214	112,243	231,703	102,039
		4	6′	364,608	163,593	280,468	148,721
		4	16′	410,761	184,301	315,970	167,546
Small Urban	43,44,45	2	0	328,429	53,591	252,638	48,719
		4	6′	437,927	102,367	336,867	93,061
		4	16′	493,360	115,325	379,508	104,841
Urban-in-Rural	46,47,48	2	0	267,749	26,673	205,961	24,248
		4	6′	337,289	38,128	259,453	34,662
		4	16′	379,984	42,955	292,295	39,050

URBAN RIGHT–OF–WAY COSTS: Cost Per Foot Width Per Mile

Urban Area Classification	CBD & Fringe	Residential & OBD	Rural
Urbanized Areas ————————	47,520	10,032	546
Small Urban (Pop.)			
5,000 - 9,999 ————————	34,426	7,392	182
10,000 - 24,999 ————————	47,520	10,032	255
25,000 - 49,999 ————————	47,520	10,032	315
Urban-in-Rural ————————	34,426	7,392	182

TABLE NO. B-11

URBAN COST SUMMARY NO. 2

URBAN CONSTRUCTION COSTS: Base & Surfacing

Urban Area Classification	D.S.N.	Lanes	Median	COST AREA ONE			COST AREA TWO		
				New&Reconst.	Resurfacing	Widening	New&Reconst.	Resurfacing	Widening
Urbanized Areas	40	2	0	216,592	1,401	176,691 + 922 W	218,669	1,280	162,130 + 1,295 W
		4	6′	296,292	+	225,719 + 922 W	307,676	+	207,866 + 1,295 W
		4	16′	376,838	1,445(W)	297,240 + 922 W	385,939	1,348(W)	273,401 + 1,295 W
	41	2	0	208,119	1,401	168,221 + 922 W	207,522	1,280	154,225 + 1,222 W
		4	6′	280,964	+	210,394 + 922 W	287,682	+	193,561 + 1,222 W
		4	16′	359,494	1,240(W)	279,900 + 922 W	363,343	1,157(W)	257,216 + 1,222 W
	42	2	0	196,431	1,401	160,162 + 841 W	192,091	1,280	146,705 + 1,043 W
		4	6′	259,676	+	195,478 + 841 W	259,796	+	179,641 + 1,043 W
		4	16′	335,387	1,042(W)	262,970 + 841 W	331,797	971(W)	241,416 + 1,043 W
Small Urban	43	2	0	238,044	1,806	181,005 + 1,324 W	242,167	1,651	166,097 + 1,752 W
		4	6′	334,543	+	233,440 + 1,324 W	349,533	+	214,968 + 1,752 W
		4	16′	420,029	1,542(W)	305,963 + 1,324 W	433,198	1,438(W)	281,427 + 1,752 W
	44	2	0	225,692	1,806	171,033 + 1,271 W	227,961	1,651	156,785 + 1,637 W
		4	6′	311,871	+	214,985 + 1,271 W	323,531	+	197,742 + 1,637 W
		4	16′	394,324	1,296(W)	285,017 + 1,271 W	403,725	1,207(W)	261,872 + 1,637 W
	45	2	0	215,954	1,806	171,033 + 1,054 W	216,947	1,651	156,785 + 1,390 W
		4	6′	294,778	+	214,985 + 1,054 W	304,228	+	197,742 + 1,390 W
		4	16′	375,067	1,296(W)	285,017 + 1,054 W	381,986	1,207(W)	261,872 + 1,390 W
Urban-in-Rural	46	2	0	226,343	1,617	178,544 + 1,120 W	226,885	1,482	163,919 + 1,462 W
		4	6′	314,028	+	229,095 + 1,120 W	322,744	+	211,127 + 1,462 W
		4	16′	396,928	1,487(W)	301,070 + 1,120 W	403,024	1,389 (W)	277,096 + 1,462 W
	47	2	0	214,893	1,617	168,932 + 1,079 W	213,299	1,482	154,927 + 1,353 W
		4	6′	292,985	+	211,310 + 1,079 W	297,851	+	194,486 + 1,353 W
		4	16′	373,058	1,250(W)	280,876 + 1,079 W	374,803	1,167(W)	258,207 + 1,353 W
	48	2	0	207,365	1,617	168,932 + 910 W	204,783	1,482	154,927 + 1,162 W
		4	6′	279,772	+	211,310 + 910 W	282,928	+	194,486 + 1,162 W
		4	16′	358,169	1,250(W)	280,876 + 910 W	357,997	1,167(W)	258,207 + 1,162 W

APPENDIX C

NEEDS ANALYSIS FOR

LOCAL ROADS AND STREETS

APPENDIX C

I. NEEDS ANALYSIS FOR LOCAL ROADS AND STREETS

A. Needs Analysis Procedure

Due to the large percentage of local road and street mileage representing relatively low cost facilities, the needs for these roads and streets are determined on a total rather than on individual section basis. The new mileage was proportioned by design and surface type according to the percentages for each category developed from the field sample made for the 1970-1990 Study. New Interstate frontage roads were omitted from the rural mass analysis. However, the maintenance costs for those roads were included in the total needs. The mileage of new urban local streets was determined and included in a separate category in the urban mass analysis.

B. Per-Mile Costs

Per-mile construction costs were developed from unit price data applied to the local road and street design standard quantities. Total per-mile costs (rather than the annual per-mile costs used in the 1970-1990 Study) for each improvement type are given in Table C-1.

Structure costs were developed for rural local roads on a square-foot-per-mile basis as related to the tolerability of the road. In other words, a typical intolerable mile of rural local road would have a certain square footage of intolerable structures. These square-foot relationships are given below.

Square Feet of Intolerable Structures Per Mile

ADT ————	≤50	50-250	250+
Cost Area 1 ——	1.172w	9.846w	57.524w
Cost Area 2 ——	2.876w	6.862w	17.742w

w = roadway width

No costs were developed for structures on urban local streets since they would represent an insignificant amount of the total costs.

Local road and street maintenance costs were derived from actual expenditures as listed in the *County and Local Road Fiscal Report* for fiscal year 1972. The total expenditures were divided by the total miles listed in the 1972 Road Log to produce both urban and rural maintenance costs.

Administrative costs were developed as a percentage of the total of construction and maintenance costs in the 1970-1990 Study. These percentages were left unchanged for this study. The administrative percentages for local roads and streets are given in Table No. 18, page 50.

C. Deficiency and Improvement Analysis for Local Roads and Streets

(1) Urban Local Streets

The urban local street mileage was stratified as tolerable or deficient for each of five design types. Each design type was divided into four surface types: high, intermediate, low, and gravel or graded and drained. All gravel or graded and drained sections in urban areas were considered presently deficient.

Improvements were categorized into five types: (1) new location, (2) reconstruction, (3) resurfacing (with sub-base), (4) resurfacing (overlay), and (5) no improvement. The improvement logic is relatively straight forward. All deficient mileage is upgraded to no less than the design standards. All gravel or graded and drained surfacing would require reconstruction and all deficient high, intermediate, or low surfacing would require resurfacing, either with sub-base or an overlay.

Resurfacing periods for paved roads were determined from survivor curves included in *Economic Analysis for Highways* by Robley Winfrey. Coupling this data with the assumption that the average life of all paved roads is equal to half their economic life results in the following percentages of presently tolerable paved roads, by surface type, that will require resurfacing by the end of the study period.

High ——————— 72% of presently tolerable miles require resurfacing

Intermediate —— 86% of presently tolerable miles require resurfacing

Low ——————— 100% of presently tolerable miles require resurfacing

(2) Rural Local Roads

The rural local road system was stratified in a manner similar to urban local streets. The difference is that only three surface types are required for the rural system: low, gravel, and graded and drained. All tolerable graded and drained roads in the low ADT design group will become deficient during the study period and require reconstruction to a gravel section. Graded and drained roads in higher ADT groups are considered presently deficient.

Gravel roads are assumed to have a total economic life of eight years. Resurfacing with 0.25 ft. of gravel every four years is considered adequate to maintain the surfacing thickness and replace the gravel lost due to traffic. The resurfacing costs for gravel roads reflect this assumption.

Again, the improvement logic dictates that any deficient section will be upgraded to no less than the design standards. In the low ADT group (less than 50 VPD), all graded and drained roads will be reconstructed to gravel; all gravel roads will be resurfaced every four years with 0.25 ft. of gravel; and all low type surfacing will be resurfaced with a

0.20 ft. overlay of plant mix. For the higher ADT design groups, all gravel and graded and drained roads will be reconstructed or resurfaced with sub-base and plant mix to a low type surfacing and all deficient low type surfacing will be resurfaced with 0.20 ft. of plant mix.

Road mix surfacing was found to be more expensive than the 0.20 ft. plant mix overlay and, therefore, was not included in the design standards.

A summary of urban and rural local road and street needs is given in Table C-2.

TABLE NO. C-1

LOCAL ROADS & STREETS TOTAL CONSTRUCTION COSTS/MILE

D.S.N.	Cost Area	IMPROVEMENT TYPE(1) 1	2	3	4	Struct.	Maint.
				URBAN			
	1	0	0	0	70,152	0	39,880
60	2	0	0	0	61,453	0	
	Avg.	0	0	0	65,803		
	1	432,639	432,639	118,134	44,895	0	
61	2	440,386	440,386	132,246	39,353	0	
	Avg.	436,513	436,513	125,190	42,124	0	
	1	290,273	290,273	0	30,162	0	
62	2	291,338	291,338	0	26,461	0	
	Avg.	290,806	290,806	0	28,312	0	
	1	319,162	319,162	69,840	32,267	0	
63	2	320,990	320,990	78,030	28,302	0	
	Avg.	320,076	320,076	73,944	30,285	0	
	1	365,210	365,210	83,286	38,581	0	
64	2	368,487	368,487	92,934	33,827	0	
	Avg.	366,849	366,849	88,110	36,204	0	
				RURAL			
	1	82,167	54,297	0	33,295	633	11,490
50	2	80,325	60,540	0	33,350	1,553	
	1	105,516	54,297	0	33,295	633	
51	2	87,436	60,540	0	33,350	1,553	
	1	124,315	54,297	0	33,295	633	
52	2	91,563	60,540	0	33,350	1,533	
	1	85,526	85,526	50,280	24,154	6,105	
53	2	78,071	78,071	55,652	23,488	4,254	
	1	120,550	120,550	50,280	24,154	6,105	
54	2	88,736	88,736	55,652	23,488	4,254	
	1	148,749	148,749	50,280	24,154	6,105	
55	2	94,927	94,927	55,652	23,488	4,254	
	1	108,567	108,567	50,280	24,154	35,665	
56	2	104,073	104,073	55,652	23,488	11,000	
	1	155,266	155,266	50,280	24,154	35,665	
57	2	118,294	118,294	55,652	23,488	11,000	
	1	192,863	192,863	50,280	24,154	35,665	
58	2	126,548	126,548	55,652	23,488	11,000	
	1	290,268	290,268	55,665	26,748	0	
62	2	291,338	291,338	61,612	26,010	0	

(1) 1 - New Location
2 - Reconstruction
3 - Resurfacing with sub-base
4 - Resurfacing, overlay

TABLE NO. C-2

LOCAL ROAD AND STREET NEEDS SUMMARY

	MILES				CONSTRUCTION COSTS			Total Construction Costs (x$1000)	Maintenance Costs (x$1000)	Total Maint. & Construction Costs (x$1000)	Admin. Costs (x$1000)	Total Needs (x$1000)
	Total	New(1)	Tolerable	Deficient	Backlog Needs (x$1000)	Future Miles(2)	Future Needs (x$1000)					
RURAL												
Cost Area 1 –	15,053.7	36.2	3,184.2	11,869.5	757,929	3,184.2	128,340	886,269	172,628	1,058,897	105,890	1,164,787
Cost Area 2 –	29,525.7	60.6	14,610.2	14,915.5	890,501	14,610.2	645,796	1,536,297	338,466	1,874,763	187,476	2,062,239
Total Rural–––	44,579.4	96.8	17,794.4	26,785.0	1,648,430	17,794.4	774,136	2,422,566	511,094	2,933,660	293,366	3,227,026
URBAN												
Billings –––	444.8	226.1	155.6	63.1	15,228	352.2	84,063	99,291	17,738	117,029	11,128	128,157
Great Falls––	303.4	105.6	125.9	71.9	23,311	211.8	40,254	63,565	12,102	75,667	7,195	82,862
Missoula –––	420.4	257.4	77.8	85.2	27,038	322.6	87,926	114,964	16,767	131,731	12,527	144,258
Total Urbanized	1,168.6	589.1	359.3	220.2	65,577	886.6	212,243	277,820	46,607	324,427	30,850	355,277
Small Urban –	1,038.9	323.8	474.0	241.1	73,569	732.8	136,440	210,009	41,432	251,441	15,111	266,552
Total Urban ––	2,207.5	912.9	833.3	461.3	139,146	1,619.4	348,683	487,829	88,039	575,868	45,961	621,829
State Total –––	46,786.9	1,009.7	18,627.7	27,246.3	1,787,576	19,413.8	1,122,819	2,910,395	599,133	3,509,528	339,327	3,848,855

(1) New rural mileage consists entirely of new Interstate Frontage Roads.

(2) Future miles are the tolerable miles that become deficient by 1990 as determined from survivor curve analyses.